



The Journal of  
Laryngology and Otology



# The Journal of Laryngology and Otology

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WALTER HOWARTH

WITH THE ASSISTANCE OF  
W. M. MOLLISON

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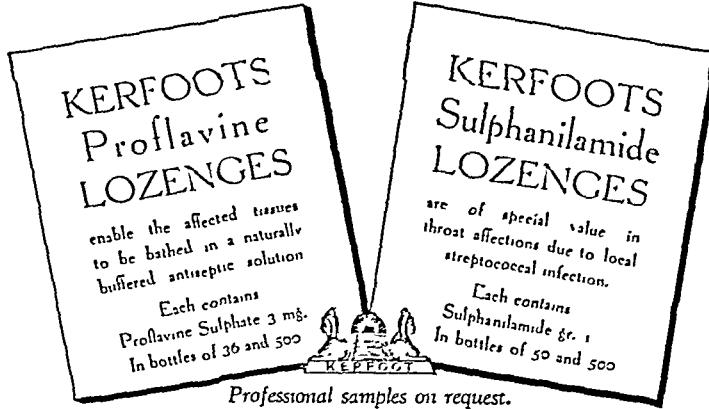
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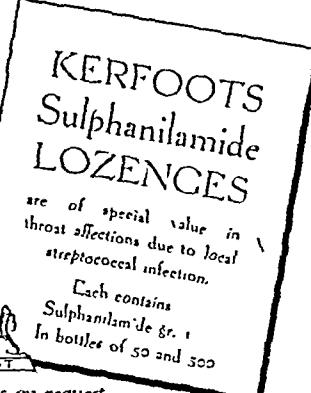
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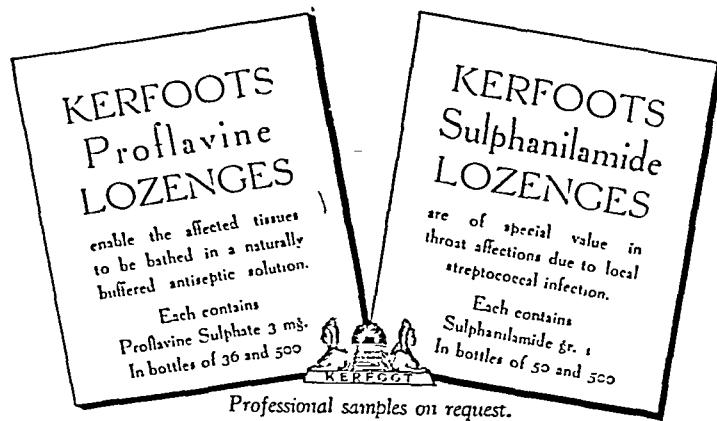
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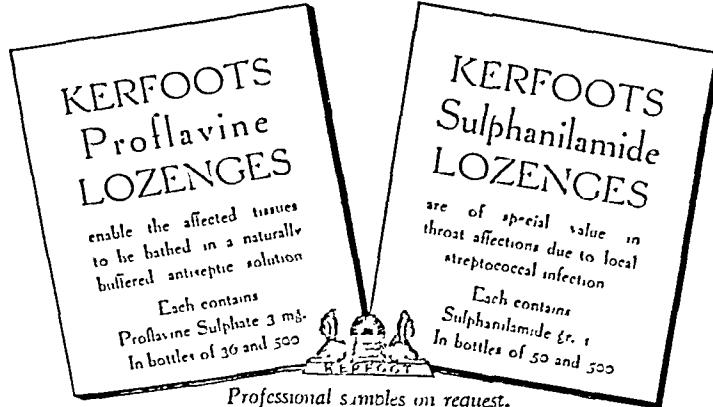
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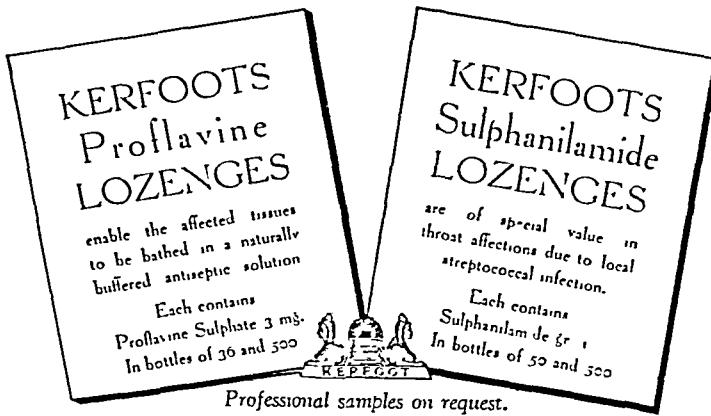
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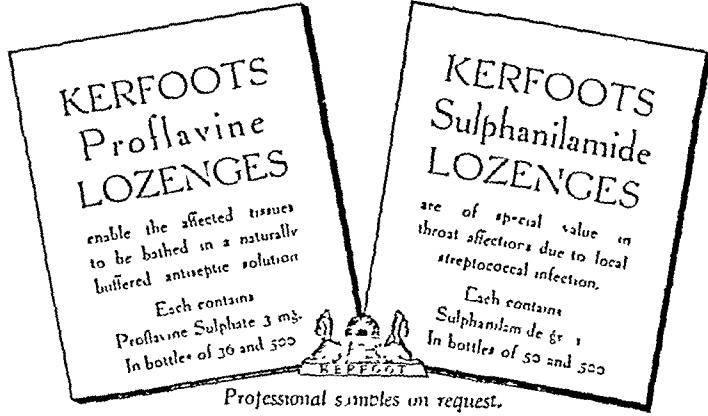
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## ŒSOPHAGEAL FOREIGN BODIES AND THEIR COMPLICATIONS

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### Number of Cases and Diagnosis

DURING the past eleven years, the total number of endoscopies performed personally is 641, made up of 57 bronchoscopies, 111 laryngoscopies, and 473 œsophagoscopies. As regards œsophagoscopy, 100 of these had foreign bodies removed by this means. The remainder consist of (1) Carcinomata diagnosis and treatment (insertion of Radon seeds, diathermy, or insertion of Souttar's Tubes); (2) strictures, some congenital, some due to swallowing of corrosives, and the large majority due to hypochromic anaemia in women; (3) cardiospasm, some due to shortened œsophagus; (4) cricopharyngeal spasm; (5) functional dysphagia; (6) three cases of diverticula. Also in this group are placed cases which were admitted for removal of a possible foreign body but in whose œsophagus nothing, or only a slight scratch could be found.

### Symptoms

When a patient reports after swallowing a foreign body, it is very difficult in some cases to assess the symptoms so as to find out whether the condition is worth further investigation. Screening, X-ray plates, a barium swallow and œsophagoscopy are not performed in every case. The patient may be rather a nervous or worrying person, and may say that swallowing of meals is normal but it hurts to swallow saliva. Quite often the patient is told that the throat is probably scratched, and that the condition will improve from day to day. If this improvement does not occur, further investigation is necessary. This would consist in "passing a large tube" or "swallowing a small amount of water". Do you feel that your complaints are not serious? Please add a few more details.

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patients. It may be said here that patients in whom for these reasons investigation has been withheld, later have never required oesophagoscopy, nor have shown any complications.

A negative screening, X-ray or barium swallow accompanied with bitter complaints of dysphagia is neglected, and the patient is oesophagoscoped. Sometimes a foreign body is found; but more often a slight wound is seen and the foreign body has gone into the stomach. With a positive result from the X-ray investigation, oesophagoscopy is essential. In a few cases a barium swallow is not now allowed, especially the use of thick barium, in a total obstruction. This leaves a thick sludge of barium all over the obstructed area, and tends to block the suction tube. In one case three suction tubes had to be used, before the foreign body could be properly seen.

### Treatment

The treatment may therefore be graded: (1) Nervous patient with indefinite symptoms—no treatment; (2) Patient with some complaints but feels oesophagoscopy is not necessary—carbolic lozenges; (3) Complaints of pain or difficulty in swallowing, negative X-ray—oesophagoscopy; (4) Positive X-ray—oesophagoscopy.

After removal of a foreign body the patient is kept in hospital for 24 hours. If there is slight injury to the oesophageal wall, the patient is given nothing by mouth except sterile water for 12 hours. If, however, there is an area of oedema in the oesophageal wall, the patient is sometimes kept in hospital for one week, and for the first 24 hours is given only sterile water. This is felt to be necessary in order to keep a patient under observation mainly for the onset of surgical emphysema, regular temperature readings or possible melena. Further X-ray examination has not been done, because in all cases information as to the possible site of perforation in the oesophageal wall has been obtained at the time of removal of the foreign body. Any further operative treatment is usually indicated by clinical examination.

### Types of Foreign Bodies

As regards the foreign bodies, all were removed endoscopically except one bone case in which the oesophagus was totally shut off by oedema (this patient died) and one denture case in which the larger half was removed but the other half was swallowed. No foreign body has been pushed into the stomach.

The large majority of these were coins—half-pennies, sixpences and shillings. There was one mental patient with two pennies lying side by side, the radiogram showing only one. One patient had swallowed a two shilling piece, with the following history: "I bet him two shillings that I could swallow a pint of beer in one swallow, with a florin at the bottom of the pint pot, and that when I had finished it, the coin would

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be left on my tongue ; and I've done it thousands of times ". Another patient who also had a delayed action swallow, had a friend who for a joke placed a metal beer-bottle cap in his beer. Both these foreign bodies were removed from the œsophagus, the metal cap owing to its shape being most dangerous and difficult to remove. There were three cases with drawing pins (U.S.A. thumb tacks), one dental clamp, three dentures, and three open safety pins (one of these cases is described later). One patient swallowed a splinter of wood in a biscuit. The splinter was 2 ins. long and lying across the cervical œsophagus, causing a perforation on both sides. This was removed without any later complication. By discreet questions it was found that the biscuit came from a large firm of manufacturers, and no hint was given at the hospital as to the possibility of damages, and so far as is known the thought had never entered the patient's head. She was very poor and may be shown as a contrast to the two well-to-do patients who swallowed chicken bones in large hotels, and immediately on discharge from hospital demanded certificates to obtain damages and medical expenses.

The next most numerous type of foreign body is described in this district as a meat bone, or the patient states : "I was eating neck of mutton". The better class patient calls it " Irish stew ", and requires some questioning before he will own up to it as neck of mutton. From my point of view I think this is important as the butcher usually chops this in one diagonal direction and then in another, so that any bones present have very sharp ends and are particularly liable to cut into the œsophageal wall. Quite often these are swallowed in a mass of meat, which makes their removal again more difficult. Another dish causing the impaction of a foreign body is chicken stew, and from the literature the Americans seem to call it chicken à la king. The post-cricoid stricture due to hypochromic anaemia is very often totally obstructed by a small bolus of meat, an article of diet which these people usually avoid.

### Complications

As regards the cases showing complications, those showing œdema of the œsophageal walls are not included, as without perforations this œdema settled down in two or three days. For example, one boy had a coin in his œsophagus for three weeks, and on removal his swallowing immediately returned to normal. Another female patient with a chicken bone impacted at the level of the arch of the aorta, required six days for her swallowing to become normal.

### Cases

Of the following cases, five showed cellulitis or abscess formation, and two of these died. One case had a prophylactic mediastinotomy performed. Three other œsophageal cases are reported.

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CASE I.—B.W. aet 44, female, was admitted to the Derbyshire Royal Infirmary on 16.4.37, with the history that four days before she had swallowed a piece of meat which became impacted in her œsophagus at the level of the bifurcation of the trachea. She had pain on the left side of her neck and a hard swelling just above the sterno-clavicular joint. There was also pain between her shoulder-blades. She had difficulty in breathing while lying down. Her temp. was 104.6 and pulse 128. She was too ill for X-ray examination. On œsophagoscopy the mucous membrane was very inflamed and after passing through the cricopharyngeal sphincter, the walls became so œdematosus that it was impossible to go any further. A left cervical incision was made and a large abscess cavity opened in the superior mediastinum. This contained exceedingly foul pus. A drain was inserted down to the arch of the aorta. It was thought that if the œdema could be lessened, another œsophagoscopy would be done in two days' time.

On 11.4.37 there was suddenly a profuse haematemesis and severe melæna and the patient died in a few hours. At post-mortem besides the abscess cavity, which was full of blood, a bone was found which had eroded its way through the aortic wall.

CASE II.—A.G. aet 3, male, was admitted to a hospital on 31.3.34 with the history of swallowing a halfpenny that same day. X-ray showed it to be in the usual position below the cricopharyngeal sphincter and just above the sterno-clavicular joints. œsophagoscopy was performed by another surgeon who removed the coin and stated that there was a slight laceration of the posterior œsophageal wall presumably due to picking up a small piece of mucous membrane with the forceps. The next day the patient had a temperature of 103 and was diagnosed as pneumonia with no signs in the chest. He came under my care on 8.4.34. His temperature was 102, pulse 130 and respirations 30-40 and was too ill to X-ray. œsophagoscopy showed a tear in the posterior œsophageal wall which led into a large abscess cavity 2 ins. in depth. The œsophagoscope was readily introduced into this and a large amount of pus removed by suction. His condition at the time was thought too bad for external incision and he died the next day.

Both these patients were neglected cases, and I think more heroic surgery was called for. In the first, the œsophagus could have been opened laterally and by retraction and if necessary insertion of the œsophagoscope through the cervical wound perhaps the foreign body could have been removed. Further injury to the œsophagus at this stage of a well-formed abscess opened and draining would not have mattered. In the second case I should have opened the neck externally. Both cases died within 24 hours of my starting treatment.

CASE III.—A.T. aet 35, male, during an epileptic fit on 29.7.36, swallowed his upper denture. X-ray showed nothing until a barium swallow was given, the obstruction being situated in the middle third of the œsophagus.

He was an extremely muscular miner nearly 14 stone in weight; the plate had two lateral hooks to attach it to both third molars. On œsophagoscopy the same day the plate had moved owing to vomiting attacks, was impacted in the cervical œsophagus, and could not be moved owing to the hooks having a secure hold on the lateral œsophageal walls. By means of Irwin Moore's scissors the plate was cut into two unequal parts, the larger on

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the right side, and this piece was mobilized and then removed with the œsophagoscope. The tube was reinserted but the patient was coming round from the anaesthetic and the injured œsophageal wall began to bleed so much that accurate movements of the remaining piece could not be performed. Also it was thought that so much injury had occurred to the œsophageal wall, that mediastinitis might be a likely sequel. Therefore preparations were made for external œsophagotomy on the left side. During this the patient came round slightly from the anaesthetic and vomited blood-stained material. The neck was incised along the anterior margin of the sterno-mastoid and by rapid dissection between the common carotid sheath and the thyroid gland, the œsophagus was displayed. No trace of injury from the left hook could be seen, nor could the remaining part of the denture be felt. With the wound still open, the œsophagoscope was for the third time passed through the mouth and the foreign body had disappeared from the œsophagus. (An X-ray the next day showed it to be in the cæcum, and two days after admission he passed it by the bowel.) To return to the cervical wound, the œsophagus was not incised, a finger was passed round the œsophagus to the right side in front of the vertebral column and a soft rubber tube inserted into the wound and round the posterior aspect of the œsophagus. The wound was then sutured. For 24 hours he was given sterile water only. X-ray examination showed some swelling of the superior mediastinum and this may have been due to my efforts at securing drainage. There was no difficulty or pain in swallowing, and the wound healed by first intention. He was discharged from hospital in ten days. In this case, therefore, external œsophagotomy was not performed, the operation being changed into a prophylactic mediastinotomy.

CASE IV.—D.W. McC., aet 43, male, was seen in consultation 20.8.39. His history began two weeks before, when eating a chicken sandwich, he felt something very sharp and painful on the right side of his throat. His swallowing afterwards was painful but with no obstruction and a doctor told him his throat was scratched but that there was no foreign body. His throat was still painful and three days later he suddenly brought up a pint of bright blood. He was taken to a hospital and kept in for one week. During this time he was seen by an ear, nose and throat surgeon, but as his swallowing was comfortable and as he had had no further bleeding, no treatment except careful dieting was advised. Two days after leaving hospital, he said he vomited another pint of blood. He was a commercial traveller and not in his own district, and so he drove himself back home to Derby where I saw him the next day.

Examination of throat was negative except for pallor due to anaemia and some tenderness and resistance of the neck just above the right sterno-clavicular joint. He had noticed no further bleeding, no trouble in swallowing, but was still passing black stools. He was very antagonistic to my suggestion that he should have an œsophagoscopy and if necessary an external operation on the neck, and the only result of my attendance was giving him a card for urgent admission when he had his next haemorrhage!

This occurred in three days' time and on œsophagoscopy that night after administration of large amounts of glucose, a tear in the right lateral wall of the œsophagus was exposed. This was half-an-inch long and a dark, firm

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blood clot filled the opening. Nothing was done to this. The next day, two-and-a-half weeks after the injury, I opened the right side of the neck and exposed the oesophagus. Dissecting down the side of the oesophagus, a cavity containing foul-smelling dark blood clot was opened. It was thought the foreign body might be still in this, and I attempted to remove this blood clot gently with a dissector. Nothing hard could be felt and suddenly the wound filled with bright blood. It seemed to come from the right innominate vein or junction of the jugular and subclavian veins and was too profuse to wait to attempt to ligature it. A roll of gauze was packed in very tightly and the skin sown up tightly over it.

Very foul-smelling serous fluid and then pus came out between the stitches and these slowly cut through and the gauze began to extrude itself. This was removed on the tenth day and the patient discharged on the fifteenth day. The convalescence was uneventful.

CASE V.—F.I., aet 51, female, was admitted on 7.8.39, with the history that she had swallowed a chicken bone four days before. Since then there had been some difficulty in swallowing solids, but on 7.8.39 she suddenly vomited about half-a-pint of bright blood. X-ray showed the shadow of a foreign body in the cervical region.

On oesophagoscopy under local a large chicken bone was removed, leaving a small area on the left wall ulcerated and causing considerable bleeding. This stopped very soon and the patient was so well next day that she discharged herself from hospital. There was no recurrence of the haemorrhage.

CASE VI.—Miss H., aet 53, was seen in consultation on 3.1.41 in the afternoon and stated that she swallowed a chicken bone at lunch and that she could feel the ends sticking in on either side at the level of the larynx. On examination, on putting in a tongue depressor the patient gagged and tried to vomit, and up behind the tongue appeared a chicken rib 2 ins. in length. After removal it was seen to be tipped with blood at both ends. The throat was seen to be clear by indirect laryngoscopy and no perforation seen. The patient was then sent home. On 6.1.41 the patient reported with a large brawny swelling on the right side extending from the mastoid to the sterno-clavicular joint. The temperature was 103 and pulse 120. She complained of acute pain to the right ear on swallowing, and could swallow only liquids. Indirect laryngeal examination showed swelling in the right sinus pyriformis. She was admitted to hospital and under a general anaesthetic the throat was examined by direct laryngoscopy. The swelling was too large to allow of examination of even the entrance to the oesophagus, and too hard to suspect pus formation as yet. However, the right side of the neck was incised at the anterior margin of the sterno-mastoid.

The jugular vein was exposed and found to be normal. Then the dissection was carried out internal to the common carotid and down to the lateral side of the oesophagus. All the tissues were in a state of cellulitis which made dissection difficult. At the entrance to the mediastinum no pus or fluid was found, but a very foul smell was noticed. A soft rubber drainage tube was inserted with its tip in this situation and the wound sutured. The patient was started on large doses of sulphapyridine by mouth and her swallowing after the operation immediately improved. The second day very foul pus was

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discharged from the wound and this continued for ten days. She was discharged from hospital two weeks after admission.

Three other cases of interest may here be reported, as in each, mediastinal infection was suspected but did not occur. (1) An infant 11 weeks old swallowed an open safety pin which had stuck in the cervical part of the œsophagus. This was seen by X-ray to be presenting point upwards. Œsophagoscopy was performed with no anæsthetic and owing to the small size of the œsophagus, the smallest bronchoscope was used. The pin was caught by its point in the right œsophageal wall and was pushed down slightly to clear the point. This was inveigled into the end of the bronchoscope and the tube rotated so that the point was impacted in the light carrier. This enabled the forceps to be introduced to the end of the bronchoscope, opened and pushed down until one could feel the resistance of the impacted pin. The forceps were then closed firmly and tube and pin removed with the keeper branch outside the tube. This manœuvre was employed owing to the small size of the tube available, as when the forceps were introduced only 1 millimetre of diameter was left for vision. The safety pin was 1 $\frac{1}{4}$  inches in length.

The child was discharged from hospital but the mother brought it back in five days' time stating that it could not swallow. Its temperature was normal and two days in the children's ward enabled the ward sister to consider its swallowing normal.

(2) A man of 84 was admitted having swallowed a complete upper plate. His gums were atrophied and he did not usually wear it but there had been a funeral from the house, and to improve his appearance his grand-children insisted that he should wear it. It was seen in the cervical œsophagus by X-ray after using barium and it was anticipated that some difficulty would be found in getting it back through the crico-pharyngeal sphincter.

He was given a general anæsthetic and on instructions was put very deeply under. The Negus large tube was used and on putting this through the sphincter a row of closely set teeth came into view. The forceps had to grip a tooth longitudinally and for this a wide grip of the hand on the forceps is necessary. Tube and foreign body were removed together and as soon as the plate reached the lips, my right hand-grip gave way and the plate dropped to the theatre floor. However, to everyone's relief it did not break. The œsophagoscope was reintroduced and tears in the mucous membrane were seen at the crico-pharyngeal sphincter on both sides. This is the largest amount of dilatation I have had to secure at this region, and the patient showed later no further complications.

(3) This is not a foreign body case. A woman of 54 was admitted with a history of difficulty in swallowing for years and owing to her anæmia, anæmic glossitis, cracks at the corners of her mouth, and

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spoon-shaped nails, was diagnosed as a post-cricoid stricture due to hypochromic anaemia ("anaemic web"). This was found on oesophagoscopy and the usual treatment in this department adopted. This consisted in dilatation rapidly with bougies to the largest size to go through the medium adult Negus oesophagoscope. Then the beak of the tube is gently pressed down on the torn "web" (it always is present posteriorly), and rotated usually to the right. The web suddenly gives way and on withdrawal the tear is seen as a diamond-shaped area through the mucous membrane exposing the muscular coat.

After the operation the patient's swallowing showed great improvement and she was told that she must again eat meat, which these patients usually avoid, and swallow it in a large bolus to keep the stricture open.

Two weeks afterwards her doctor sent her in moribund. After leaving the hospital, her dysphagia became worse and she could take only milk and water. On re-admission she was too ill to investigate and was given an intensive course of nutrient enemata. Her swallowing did not improve but there was no tenderness in the neck. Five days after admission she died. This was thought to be mediastinitis and it was rather a blow to me, as about 40 patients have been treated in like manner for this condition without any complications. But at post-mortem an ulcerating squamous-celled carcinoma was found in the lower third of the oesophagus. The combination of the two pathological conditions is in agreement with Simpson's article, and seems to point out the necessity for a complete oesophageal examination after the dilatation of such a stricture. Also at the post-mortem the stricture area was found to be healing well and showing quite a large lumen.

### Discussion

Various authorities have reported their cases of this condition and the earlier investigators certainly achieved a fairly high mortality. This was due to two reasons, the poor type of the instruments compared with modern standards and the large number of late cases they had to deal with. Killian's cases (1920) occurred too early for comparison; 380 cases between 1900 and 1922 and out of these 169 required external operations for infection; 70 of these died.

Schlemmer (1920) reported 529 cases with 15 deaths from 1909—1919. These were under the care of Höfer, Kahler, Neumann, Kofler, Chiari, Marschik or Schlemmer. For these 529 foreign bodies, 1,657 oesophagoscopies were performed, and more recently the number of unnecessary oesophagoscopies has been reduced by the improvement in radiographs. Also, most of the cases had been subjected to quite a bit of forcible bougie work before being sent up. During the 1914—1918 war there was a shortage of coins, and possibly more difficult foreign bodies were selected at that time by the children in Vienna. Sixteen external

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operations were required, and eight of these were external œsophagotomies of which five recovered. As regards haemorrhage as a complication, Neumann operated without success on one case in which the right carotid was injured by the foreign body. Another case died from haemorrhage from the left internal jugular vein. One case with mediastinitis had a thrombosed internal jugular vein but the large majority died from mediastinitis. This long article contains points of great interest mainly due to its detailed clinical material.

Then came reports of Chevalier Jackson's work, firstly 204 cases with three deaths, one from septic pneumonia and two from mediastinitis. This work finally reached the extensive results published in 1936. Here, however, the mortality rate is still 2 per cent., which is due to late cases and cases who have been œsophagoscoped previously.

Alpin (1934) in 10 years had 90 foreign body cases. Sixty were removed, 3 had œsophageal wall abscesses, 5 cases required collar mediastinotomy and 1 case died of mediastinitis. Macmillan (1935) reported 183 cases of foreign bodies in the œsophagus in 10 years. These represented 30 per cent. of œsophageal cases. Mosher (1935) reported 938 œsophagoscopies in 12 years with 19 fatalities. He had 285 foreign body cases with two fatalities.

In this country several reports have been made. Crow (1930) reported 30 foreign bodies removed from the air and food passages, and of these 25 were removed from the œsophagus with no complications. This paper was followed by a long discussion which was side-tracked by an enthusiast for the archaic coin-catcher. These methods were largely condemned, and the general opinion of the meeting was that in doubt in injury or cellulitis of the neck internal methods were more dangerous and an external operation should be performed.

Downer (1932) removed a safety pin 2 inches in length from a child of 8 months, again with no complications, although the point was buried in the wall of the œsophagus. Holt Diggle (1932) reported 67 œsophagoscopies for removal of foreign bodies; 58 were removed, and there was 1 death from broncho-pneumonia. Souper (1934) reported 2 fatalities due to the use of bougies, one of these dying of haematemesis from a peri-œsophageal abscess opening into the left subclavian artery. The number of cases œsophagoscoped for foreign bodies was not given. McGibbon and Mather (1935) reported 3 cases of mediastinitis after œsophagoscopy for foreign bodies. One died one week after discharge from hospital. The others recovered without further intervention. Possible radiographic signs are discussed, but in their indications for external operation, the general condition of the patient seems to be the most important guide.

After 1920 started the debate for and against external operation for mediastinitis. Conservative treatment was advocated by von Eicken

(1923), who reported mediastinitis in 8 cases, all of which recovered and Mosher (1920), who reported two recoveries and one case with thrombosis of the internal jugular vein. Guthrie (1923) had one case with swelling of the neck, with an abscess discharging pus into the oesophagus ; removal of the foreign body was sufficient to cause the whole condition to subside. Moersch and Kirklin (1933) reported one case in which a toy horse and rider had ulcerated through the oesophageal wall into the mediastinum. This was removed by the oesophagoscope under radiographic control three months after it had been swallowed. In two days the temperature which had been 104, had dropped to normal. Clerf (1926) reported three cases of peri-oesophageal swelling, all with symptoms of toxæmia and all three recovered without surgery apart from removal of the foreign body. One was a "safety-pin case" with a temperature of 105. Tilley (1927) reported three cases in which external swelling was present in the neck, and removal of the foreign body caused a gush of pus into the lumen of the oesophagus. Two recovered and the third went on to mediastinitis and death. In these cases the after-treatment consisted of nutrient enemata for three days and the only liquid allowed by the mouth was a mixture containing bismuth carbonate in suspension.

King (1929) reported 6 cases of complications after oesophagoscopy, 5 recovered without any surgery and 1 died after an external operation which was performed on the ninth day, the patient dying 12 hours afterwards. Orton (1930) reported 6 cases of mediastinitis with no external operation and one recovery. He advised gastrostomy to rest the oesophagus, and feed the patient, and for the purposes of discussion at this meeting, stated that there were two points of view, one, to call in a thoracic surgeon immediately, and two, to delay this until an abscess could be walled-off. These results were reported as a warning that external operation should be advocated.

Internal drainage of a peri-oesophageal collection has been advised by a number of authors. Tucker (1925) opened an abscess through the oesophageal wall after a puncture from a fish-bone. The patient recovered. Seiffert (1928) put forward his operation of splitting with scissors the posterior wall of the oesophagus in the mid-line, in order to open a peri-oesophageal abscess. Vogel (1937) also supported this if the perforation was visible, but, if a perforation could not be found, external mediastinotomy was advised and then the splitting operation could be performed from the site of the infection. He stated that the operation should be performed in the first 24 hours after mediastinitis was suspected. Nine cases were reported and four of these died. Guthrie (1933) reported a case in which a halfpenny with a worn edge was caught by the coin-catcher and pulled through the oesophageal wall. An incision was made in the posterior wall of the hypopharynx, and the coin removed without any later complications. Wright (1934) reported 3 cases of mediastinitis

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with 1 death. One with a chicken bone, another with a bone from Irish stew and a less wealthy patient who ate neck of mutton. The chicken bone case died of mediastinitis with pus in the posterior mediastinum and right pleural cavity. In the second case the neck was opened seven days after removal of the foreign body and a fistula resulted. This healed after a gastrostomy. The third case was dealt with by the internal route forceps being passed through the visible perforation into an abscess cavity. Kramer (1929) developed the technique of punching out the edges of the perforation in order to provide adequate internal drainage. He reported three quite severe cases of peri-œsophageal abscesses and secured recovery in all three. Later (1930) he had a case in which after an œsophageal perforation near the cardia, he performed this operation, but the patient died with thrombosis of the vena azygos major and at necropsy the original condition had cleared up. He also reported another successful case. Watson-Williams (1929) reported an unsuccessful case in which after punching out the edges of the perforation, the abscess seemed to drain satisfactorily but the patient died of broncho-pneumonia. At necropsy a large abscess was found extending downwards from the opening below the cricoid to the root of the left lung. The author wondered whether nursing in the head-down position might assist drainage, and he also thought of enlarging the opening by scissors as advocated by Guisez (1922).

The supporters of external operation are much more numerous. The cervical route has been used in most cases, but in the lower part of the œsophagus thoracic operations are necessary. The cervical route is the only one considered here and this is used in three types of cases : (1) prophylactic mediastinotomy ; (2) the drainage of an abscess ; and (3) œsophagotomy. The older writers speak of this as Marschik's operation and in Schlemmer's reports, he certainly has performed most of these operations.

The largest number of cases is that of Phillips (1938), who had 20 cases of mediastinal infection with 3 deaths. These cases came from a series of 5,000 œsophagoscopies and were not all foreign body cases. He advises the external operation in the cervical region and irrigation of sodium hypochlorite with Dakin tubes. The three fatal cases showed : (1) a sloughing of a section of the œsophageal wall, and haemorrhage ; (2) double pneumothorax ; and (3) spreading infection in the mediastinum, operation two days later, but death from septicaemia. The last case was due to the passage of a dilator for cardiospasm.

Head (1938) reports five cases but does not state the number of œsophagoscopies. Each had mediastinitis, but two cases developed pneumothorax. There was one death. He is of the opinion that the large majority of infections occur in the lower cervical region and that cervical mediastinotomy is effective down to the fourth dorsal vertebra.

Guns (1937) reported 4 cases of mediastinotomy; 3 were for dentures impacted in the oesophagus and 1 for a bone. This last case was the only death, and the foreign body was impacted for 8 days. His opinion is that late symptoms are pain in the back, neck and ears, and early signs are subcutaneous emphysema and the radiographic appearances of this. Minnigerode (1923), McGibbon and Mather (1935), and Iglauer and Ransohoff (1924) stress the importance of the early radiographic appearance of mediastinal emphysema. At the same time, when the indications for external operation are given, they differ very little from those of Killian (1920). Piquet and Debarge (1935) report one case of cervical mediastinotomy and gives a detailed description of the operation; which is along the same lines as Marschik's (1920). Pearse (1933) describes his operation and states that the Marschik operation is too high and he inserts his packing in the prophylactic mediastinotomy always below the omohyoid. He advises in doubt to extend the area of drainage behind the oesophagus for posterior wall infections and even to perform it on both sides. Furstenburg (1929) advocates thoracic mediastinotomy below the fourth thoracic vertebra and cervical above this. He inserts a drainage tube along the lateral oesophageal wall and claims that the operation is more easily performed on the right side as there is more room. Wessely (1934) reports a series during 15 years of 56 collar mediastinotomies (Marschik) in 98 cases of inflammatory conditions in the cellular tissues of the neck. Of the 56 cases, 31 recovered, and 25 died. These operations were performed either for drainage or as a prophylactic against mediastinitis. However, in the last seven years no preventive operations were performed and the percentage of recoveries were the same and Hajek gave his opinion that the inflammatory process itself creates a barrier. Wessely noted tenderness over the vessel sheath but thought that most important was the low-grade oedema in the lower third of the neck.

As regards haemorrhage, Ter-Oganesjan (1934) reported 5 cases all of which died, and he advocated mediastinotomy as soon as bleeding occurred. Negus (1932) reported one case in which the right common carotid was ruptured owing to an extension of a lateral pharyngeal abscess leading from a perforation in the right pyriform fossa. Hajek (1935), Scoville (1924) and Kirby all report cases in which a foreign body has caused erosion of the right subclavian artery which has followed an abnormal course, this artery coming off the aortic arch last and running behind the oesophagus. I have demonstrated one case of this during oesophagoscopy when a large transverse swelling could be seen pulsating against the posterior wall of the hypopharynx. This anomalous course is a peculiarity described in anatomical text-books, and the right sub-clavian artery in this course may even pass between the trachea and oesophagus. The posterior position is of importance,

## Œsophageal Foreign Bodies

not only from the point of view of foreign bodies but in any œsophagoscopy.

Mosher (1935) states : " Every œsophageal examination and every passage of a bougie with or without ether is a potential tragedy ". The table enclosed seems to be a definite answer to this. In unskilled hands obviously a thin muscular tube is certainly not sufficient protection against rough treatment. Most of the deaths are due to cases being sent too late, or even already in a state of mediastinitis. It is a question, however, whether symptoms of mediastinitis or haemorrhage are suitably recognized as requiring cervical mediastinotomy. Better results are obtained by early operation, and the hope of obtaining a walled-off abscess is rather vain in the delicate areolar tissue occupying the mediastinum. Subcutaneous emphysema after an œsophagoscopy is a warning, but pain, anxiety, temperature and general toxæmia are absolute indications. Usually there is dysphagia or pain on swallowing, but these also are not always present.

Again, subcutaneous emphysema alone with rapidly increasing anxiety, difficulty in breathing and cyanosis may mean not only mediastinal emphysema but also pneumothorax unilateral or bilateral. This arises by puncture through weak areas of the mediastinal pleura from the slowly increasing pressure of the air in the mediastinum. This has been seen in low cervical operations where there has been laryngeal obstruction and the reverse has occurred in artificial pneumothorax. Therefore, in a case of mediastinal emphysema where there is not much toxæmia and the patient is rapidly becoming worse, it is as well to exclude pneumothorax.

### Conclusion

If these indications are borne in mind, there are several means at our disposal.

(1) Internal dilation of a perforation by forceps, punch forceps or scissors. This may be followed by nursing in the head down position. A feeding tube may be inserted into the stomach. Gastrostomy may be performed.

(2) If, however, the patient is still very ill, or the cavity seen through the perforation is large, then external operation should be performed. Also, sometimes the swelling of the œsophageal wall will not permit the passage of an œsophagoscope, and in this case an external opening should be made, an attempt to find the perforation, dilatation of this by scissors until the œsophagoscope can be passed or a feeding tube inserted, or even external œsophagotomy. If an incision is to be made in the œsophagus, it is made best in the posterior wall as in Seiffert's splitting operation. Gastrostomy must be considered. These methods are to be advocated in every case of mediastinitis associated with a sharp pointed foreign body.

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(3) In a case, however, when a smooth or rounded foreign body is present, but has been *in situ* for such a time as to have caused mediastinitis, the mediastinal condition may be dealt with and then time may be allowed for the œsophageal swelling to subside and allow œsophagoscopy.

(4) As regards the value of prophylactic mediastinotomy. Wessely is not very impressed, but some of his cases had cervical infections already in action, and his operation then was too late and only encouraged the spread of infection. But in the case of a much injured œsophagus, it is felt that the insertion of drainage tubes through an external wound has a very good hypnotic action on the surgeon.

(5) It will have been noticed that only one case has received sulpha-pyridine, and of course the sulphonamides have reduced the necessity of external operation. Also, penicillin by intramuscular injection, and local use in an external wound, should render these very severe complications much less dangerous to life.

Name and Year	No. of Œsophagoscopies and Time	FBS. rem.	Mediastinotomy	Deaths
Schlemmer 1920	1,657 (FBS. only)	10 yrs.	529	16
Holt Diggle 1932	67 (FBS. only)	10 yrs.	58	0
Alpin 1934	90 (FBS. only)	10 yrs.	60	1
Mosher 1935	938	12 yrs.	285	1
Jackson 1936	not stated		1,375	2
Phillips 1938	5,000		not stated	8
Author 1941	473	11 yrs.	100	3
			not stated	2
			20	2
			5	

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# A SERIES OF 50 CASES OF ACUTE AND SUBACUTE MASTOIDITIS TREATED BY CLOSURE OF WOUND AND PERfusion WITH PENICILLIN

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IN bringing forward this short series of cases, it is my wish to illustrate a possible use of Penicillin, rather than to make a comparison between the method described below and other methods of treatment of cortical mastoidectomy cavities.

Florey and Florey have given an account of the properties and mode of action of Penicillin in their original article (*Lancet* 1943, p. 387); and in this they mentioned the first few cases of the present series, which were treated under their supervision. It was upon the basis of experience gained in these early cases that the treatment of war wounds as closed cavities was later developed.

## The Material

The cases are divided into two series. The first 20 were treated in the early months of 1942\*; and the subsequent 30 in the corresponding months of 1943. That they were not a continuous series is due to the shortness of the supply of the drug at the time. They were taken without selection and were those presenting themselves at this hospital in the months and years mentioned, and deemed to need a cortical operation for acute or subacute mastoiditis. The operations were performed by Mr. Gavin Livingstone, by myself, or by one of our House-Surgeons under our personal supervision.

Included in the series were a number of classical cases with subperiosteal oedema; two of the acute fulminating type; one in which there was a perisinous abscess with granulations on the wall of the lateral sinus; and two of acute mastoiditis in elderly diabetics. The ages of the patients ranged from 2 months to 76 years.

## The Technique

This varied a little as the series progressed, but eventually we developed what has since become our standard technique. After the performance of an apparently complete cortical operation the haemostasis

\* These were reported verbally at the Section of Otology R.S.M., July, 1942, but not published for security reasons.

## Acute and Subacute Mastoiditis

of the superficial wound was achieved with greater care than had been our usual practice, and the skin was sewn up completely. A fine rubber tube (English catheter size 12) was inserted at the upper end of the wound and sewn into place, so that its lower end reached just short of the lowest point in the mastoid cavity. Penicillin solution was then run into the tube from a glass syringe until it oozed out of the incision line. A sterilized wooden spigot was then inserted into the open end of the tube and this, in its turn, was covered with a sterilized glove-finger. This last was held in position by means of a small rubber band.

In all the cases Calcium Penicillin dissolved in distilled H<sub>2</sub>O was used; in the first 20 at a strength of 250 units per c.c., and in the remaining 30 at a strength of 500 units per c.c.

A thin layer of vaseline, incorporating a watery solution of Penicillin, was then spread over the wound and plenty of dry gauze dressing and cotton wool applied. The tube carrying its spigot and glove-finger was allowed to protrude between the layers of the bandage. (In the first 10 cases the vaseline was omitted.)

### After-Treatment

Cases 1 and 2 were treated with too little Penicillin, and their wounds were not stitched up tightly enough and therefore leaked.

Cases 3 to 20 were given suction-perfusions six-hourly with Penicillin 250 units per c.c.

Cases 21 to 27 were treated twelve-hourly with Penicillin 500 units per c.c.; this was thought to be too infrequently in the light of results.

Cases 28 to 39 were treated eight-hourly with the stronger solution.

Cases 40 to 50 were treated six-hourly with the stronger solution.

On balance, I think that the six-hourly technique is worth while.

In such cases Penicillin has been recovered from the urine. In two cases (Nos. 8 and 25) suffering from bilateral otitis media, where the one ear was chronologically of longer standing, that of more recent occurrence dried up while the first mastoid was being treated, only to recommence to discharge when the treatment ceased. It would seem, therefore, that a certain amount of absorption of Penicillin occurs from a mastoidectomy wound, and that this may exert a favourable influence upon co-existing infective conditions.

The routine finally adopted was as follows:—The dressing was not disturbed for five days. During this time, at six-hourly intervals the glove-finger and spigot were removed, the wound evacuated by suction with a 10 c.c. glass syringe; and an amount of Penicillin was run in from another sterile syringe, equal to the amount of fluid withdrawn. Suction was usually productive of a little blood, fibrinous clots and

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## FIRST SERIES

No	Case	Age in Years	Duration of ear Symptoms	Previous Chemo Therapy	Culture	Ear Dry	Wound Dry	Subsequent Cultures	Complications	Remarks
1	O K	18	4 days (L) 9 days (R)	- +	$\beta$ Haem strep 2 $\beta$ Haem strep 13	14 days 7 days	12 weeks 4 weeks	P's Pyo B H S 2 $\beta$ Haem strep	Cellulitis round wound Acute "identis" 8th day, contralateral side Adenitis 8th day, Cellulitis scalp 21st day	To little Penicillin To little Penicillin
2	G S	10	9 days (L)	+	Pneumococcus	-	11 days	$\beta$ Haem strep	Secondary drainage of cavity in Oxford; re opening by Mr Colledge	
3	J G.	13	9 days (L)	+	$\beta$ Haem strep $\beta$ Haem strep	8 days 7 days	8 days 11 days	-	Later acute appendicitis, peritonitis	
4	T McD	4	9 days (R) 10 days (R)	- +	$\beta$ Haem strep $\beta$ Haem strep	-	-	-	Adenitis	
5	J W	13	9 days (R) 10 days (R)	- +	$\beta$ Haem strep $\beta$ Haem strep	-	-	-	Stitch abscesses, Tonsillitis	
6	A G	7	2 weeks (R)	-	$\beta$ Haem strep Pneumococcus	9 days 5 days	13 days 12 days	$\beta$ H S, and $\beta$ Staph aureus $\beta$ Haem strep	Superficial cellulitis cheek	
7	M W	1	2 weeks (L)	-	$\beta$ Haem strep 13	7 days	44 days	$\beta$ Haem strep and pyo	Sterile	
8	J B	5	3 weeks (L)	-	$\beta$ Haem strep 13	5 days	10 days	-	-	
9	J B	5	5 weeks (R)	-	Staph aureus	-	-	-	-	
10	G C	21	3 weeks (R)	-	-	-	-	-	-	
11	J L	1	3 weeks (L)	-	-	-	-	-	-	
12	V S	5	4 weeks (L)	-	$\beta$ Haem strep Pneumococcus 3	5 days	10 days	Sterile P's Pyo	-	
13	L T	76	4 weeks (R)	-	$\beta$ Haem strep Pneumococcus 3	5 days	14 days	-	Collection serous fluid under scr 11th day	
14	C H.	5	5 weeks (L)	-	Pneumococcus	5 days	13 days	-	-	
15	J C	9	5 weeks (L)	-	Sterile	25 days	25 days	"Staph aureus	Acute on chronic condition Cells +	
16	A D	5/12	4 weeks (L)	-	-	-	-	-	Lower end of wound opened slightly and oozed	
17	P D	1	12 weeks (L)	-	Haem influenzae	5 days	8 days	-	Stitch opened	
18	V H	1	16 weeks (R)	-	Sterile	11 days	11 days	-	-	
19	A B	1	24 weeks (R)	-	Staph aureus	5 days	14 days	Staph aureus	R mastectomy 2½ mths previously heralded in 5 wks	
20	A B	1	24 weeks (L)	-	Pneumococcus	9 days	12 days	-	Previous ear swab, Pneumo- coccius	
21	R H	5	3 weeks (L)	-	$\beta$ Haem strep	13 days	14 days	-	Mastoidectomy	
22	G B	9	8 days (R)	-	Sterile	10 days	13 days	-	Had had Staphylococcal bone lesion 3/12 previously treated Penicillin system- ically. This was a "re- current" case	
23	J A	3	7 days (R)	-	$\beta$ Haem strep $\beta$ Haem strep	7 days	28 days	-	Recurrent	
24	K M	8	21 days (L)	-	$\beta$ Haem strep $\beta$ Haem strep	7 days	14 days	+ at 5 and 12 days Staph aureus from stitch holes	Wound broke down partially	
25	C P J	3	6 weeks (R)	-	-	5 days	14 days	-	Onset left otitis media 2 days, post op	

# Acute and Subacute Mastoiditis

No.	Case	Age in Years	Duration of ear Symptoms	Culture	Ear Dry	Wound Dry	Subsequent Cultures	Complications	Remarks
26	C.R.J. D.W.	3 13/12	11 days (L) "Some weeks" (R) to 5 days (L)	$\beta$ Hanc, strep. Staph, albus Pneumococcus Type 3	5 days 5 days	8 days 12 days	— 4th day Sterile	— —	Right otitis, recurred when penicillin discontinued, on left Mild diabetic
27	J.S.	8/12	1 month (R)	Pneumococcus Type 3	5 days	7 days	—	—	—
28	J.H.	60	4 weeks (R) 2 months (L)	$\beta$ Hanc, strep. $\beta$ Hanc, strep. $\beta$ Hanc, strep. $\beta$ Hanc, strep. Sterile	5 days	7 days	—	—	—
29	F.H.	60	1 month (R)	Pneumococcus Type 3	7 days	10 days 13 days 7 days 7 days	Sterile on 5th day Sterile on 3rd day	—	No records from 7th day to 2 1/2 later
30	M.H.	22	4 weeks (R) 2 months (L)	$\beta$ Hanc, strep. $\beta$ Hanc, strep. $\beta$ Hanc, strep. $\beta$ Hanc, strep. Sterile	7 days	13 days 2 months	— 7 days, $\beta$ Hanc, strep.	—	Otorrhoea recommended 14th day and continued for 7 months. Possibly mentally defective
31	H.M.	6	3 weeks (L)	—	7 days	11 days	—	—	—
32	C.B.	5	3 weeks (L)	—	7 days	12 days	—	—	—
33	J.H.	11	3 weeks (L)	—	7 days	12 days	—	—	—
34	S.W.	4	2 months (R)	—	7 days	12 days	—	—	—
35	M.M.	34	4 weeks (L)	+ $\beta$ Hanc, strep. $\beta$ Hanc, strep. $\beta$ Hanc, strep. $\beta$ Hanc, strep.	7 days	14 days 20 days 13 days 5 days	7 days, sterile —	—	Right ear broke down, Healed when left mastoid had been opened
36	N.L.	26	5 weeks (L)	+ $\beta$ Hanc, strep. $\beta$ Hanc, strep. $\beta$ Hanc, strep.	7 days	11 days	—	—	—
37	H.S.	17/12	8 weeks (R)	+ $\beta$ Hanc, strep. $\beta$ Hanc, strep.	7 days	11 weeks	—	—	—
38	I.A.	44	3 weeks (R)	+ $\beta$ Hanc, strep. $\beta$ Hanc, strep. $\beta$ Hanc, strep.	7 days	11 days 13 days 5 days	—	—	Swab not cultured im- mediately
39	I.A.	44	16 days (L)	— $\beta$ Hanc, strep. $\beta$ Hanc, strep. Sterile	7 days	21 days 9 days 5 days	5th day, sterile	—	Case of Gradenigo's syn- drome, transferred from Neurosurgical Dept. Co-existent right antral infection, not treated. Severe otitis externa. Ear repeatedly picked and scratched.
40	T.L.	6	2 weeks (R)	+ $\beta$ Hanc, strep. $\beta$ Hanc, strep.	7 days	9 days 7 days 5 days	—	—	—
41	M.D.	3	3 weeks (R)	+ $\beta$ Hanc, strep. $\beta$ Hanc, strep.	12 days	7 days 16 days	—	—	—
42	C.O.D.	34	Uncertain (R)	+ $\beta$ Hanc, strep. $\beta$ Hanc, strep.	7 days	4 weeks 9 days 10 days	—	—	Co-existent right antral infection, not treated. Severe otitis externa. Ear repeatedly picked and scratched.
43	L.M.	13	5 weeks (R)	+ $\beta$ Hanc, strep. $\beta$ Hanc, strep.	7 weeks	4 weeks 9 days 20 days	5th day, $\beta$ Hanc, strep. —	—	—
44	S.P.	11	6 weeks (L)	— $\beta$ Hanc, strep.	4 weeks	4 weeks 9 days	5th day, $\beta$ Hanc, strep. —	—	—
45	R.W.	24	3 weeks (L)	— $\beta$ Hanc, strep.	7 weeks	7 days	1 week, Staph. aureus	—	—
46	G.B.	28	2 months (R)	— Staph, aureus	—	—	(Not recorded) 5 days 3 days 5 days	—	—
47	R.F.	1	2 weeks (L)	— Sterile	—	—	5 days 8 days	—	Had had lobar pneumonia during which became deaf
48	D.S.	19	4 weeks (R)	+ Sterile	—	—	—	—	—
49	C.P.	50	2 weeks (R)	+ Sterile	—	—	—	—	—
50	J.N.	2/12	7 days (R)	— Pneumococcus	—	—	5th day culture sterile	—	—

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Penicillin, and was the only part of the treatment which the patients found uncomfortable : we thought it, possibly incorrectly, to be an essential manœuvre for successful treatment. The amount of Penicillin used on each occasion depended upon the size of the cavity and varied from 1 to 4 c.c. The amount gradually diminished with each dressing.

On the fifth day after operation, the dressing was taken down and the stitches removed. The incision was then usually healed except where the tube was inserted, and in the majority of the cases there was no inflammatory reaction around the stitch holes. The external auditory meatus was usually moist with a mixture of blood and Penicillin, but with very few exceptions, there was no muco-pus. Penicillin in vaseline was applied to the suture line.

The suction-perfusion technique was carried out twice daily for a further two days, after which the rubber tube was removed, and Penicillin in vaseline again applied to the incision. The wound was usually firmly healed, except for a tiny slough at the site where the tube had been. By this time, too, the skin was commencing to fall into the cavity and to present a concave appearance.

In the successfully treated cases, no further treatment was carried out, but the patients were kept in hospital till the fourteenth day after the operation, in order that they might be observed.

The method of treatment was well tolerated by the patients ; it was noted how rapidly the stiffness of the neck, usually seen in acute cases, disappeared. Temperature and pulse rate fell by lysis. The technique made no extravagant demands upon the nursing staff ; and the Department Sister agreed that when once it had been established as a routine, it was rather less trouble in the long run than the traditional dressing methods.

In none of the cases did any of the recognized serious complications of mastoiditis occur, not even in Case 15, where the stage was set because of the presence of a perisinous abscess.

It would appear from the fact that the area behind the pinna became concave almost at once on healing, that there was a minimum of granulation tissue formation in the cavities, and therefore a minimal tendency to "pocket". This is in accordance with experience with Penicillin applied locally to wounds elsewhere.

The bacteriostatic properties of Penicillin and the closed wound are both important in keeping out secondary infection of ward sources.

### Bacteriology

This was investigated partly at the Emergency Public Health Laboratory and partly in the Department of Pathology in the Radcliffe Infirmary.

## Acute and Subacute Mastoiditis

A swab was taken from the operation wound in all but three cases. These were reported as follows :—

$\beta$ haemolytic streptococcus	..	..	..	27 cases
Pneumococcus	..	..	..	8 "
Staphylococcus aureus	..	..	..	3 "
Staphylococcus albus	..	..	..	1 "
Hæmophilus influenzae	..	..	..	1 "
Sterile	..	..	..	7 "

In three cases the superficial wound became contaminated with *Ps. pyocyanus*, but two of these healed rapidly in spite of such contamination.

In the case reported as due to *H. influenzae*, a meatal swab had previously yielded a pneumococcus.

The cases reported as sterile were usually those in which there had been some delay in the swab finding its way to the culture plate.

### Analysis of the Cases

The dressings were not disturbed for five days, and therefore it is not known if, in fact, the meatus was ever dry in less than that number of days. In some cases it probably was so. Where only a little blood-stained moisture was found, the case has been called "dry" at fifth day; there were 23 such cases. In 12 more the ear was dry at the second dressing, on the seventh day after operation.

In recording the number of days before wound-healing took place, care has been taken to err on the side of generosity and to accept no case as healed which still required even an adhesive dressing. It is thought that had lower figures been given in a number of cases, the technical inaccuracy might have been pardoned.

The most successful cases appear to have been those in which Sulphonamide drugs had been given before operation, or during the post-operative phase. In the first 20 cases Sulphonamides were not given to the patients in the hospital, as it had been desired to assess one line of treatment only. However, in the later series it was felt to be permissible to give Sulphonamides in acutely ill cases.

Apart from those cases in which the Penicillin dosage had been too meagre, or in which the patients picked up a cross-infection in the ward, the least successful cases were those in which the concomitant and underlying upper respiratory infection did not receive adequate treatment. It is my view that the local application of Penicillin to the mastoid cavity should be accompanied by, or preceded by a full dosage of Sulphonamide drug by the mouth, and that such a combination is likely

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to lead to the most satisfactory results.\* Nasal Sinusitis should in addition receive adequate local treatment.

## The Unsuccessful Cases

Included here are those in which healing of ear and wound compared unfavourably with the average.

No. 1 (O.K.) was an acutely ill fulminating case due to haemolytic streptococcus, with nasopharyngeal infection and enlarged cervical glands. She had a large cellular mastoid cavity. Unfortunately, too little Penicillin was used; and the tube was not stitched in place, so that the retained fluid was not sucked out properly before each injection. She belonged to the category which one hitherto would have treated with Sulphonamide by the mouth. She did not receive this, as we did not wish to complicate the treatment. Her wound had broken down before the first dressing on the fifth day, so that it was not possible to retain the Penicillin. Though the ear was dry in ten days, the wound failed to heal completely for nine weeks.

No. 2 (G.S.) developed a streptococcal otitis media after mumps. In spite of considerable cervical swelling, primary healing had apparently occurred by the fifth day, though the ear was discharging still. A slight serous leak was present on the seventh, when the Penicillin was discontinued. Two days later he developed a pyrexia and cervical adenitis on the contralateral side. Concurrently with this, the wound broke down more extensively and discharged pus; complete healing not being obtained for some weeks. (Went home to London.)

No. 3 (J.G.) was a case where conservative treatment coupled with Sulphapyridine had failed to cause subsidence of a pneumococcal infection. His wound healed by primary intention and his ear was dry by the tenth day. He developed at this stage an adenitis on the contralateral side to his mastoid (contemporaneously with the patient G.S.). Even so, his wound did not break down though his ear was discharging a little muco-pus on leaving hospital. Some days later he developed pyrexia and swelling of the scalp above the mastoid wound. This was opened and drained at the upper extremity, but eventually the lower extremity broke down as well. On this occasion, the infection was found to be due to a streptococcus.

He still had a slight discharge from his wound on returning home to London, where Mr. Colledge saw him and reopened the cavity completely.

\* Experience has shown that treatment of sepsis by means of penicillin given systemically does not take the place of adequate surgical drainage, where pus has formed. But it is possible that, in early cases of acute mastoiditis, where a perforation of the tympanic membrane already exists, a resolution of the pathological process may be brought about by giving Penicillin systemically. Two such cases have been observed, where penicillin was given systemically for meningitis secondary to early otitis media. In both of these there was X-ray evidence of Pathology in the mastoid process, and in both the ear ceased to discharge a few days after commencement of treatment.

## Acute and Subacute Mastoiditis

In a verbal communication, Mr. Colledge has told me that there was surprisingly little pus present, that granulations were minimal, and that the cavity was healing by fibrosis. On reviewing this case, I feel that we should have recommenced the Penicillin treatment at the time of his second admission to this hospital.

No. 15 (J.C.) had a very extensive cavity and perisinous abscess. Her wound healed by primary intention but the ear was not dry when the Penicillin was discontinued. It later broke open slightly at the base and oozed for a third week. This patient was an evacuee child and the history on admission was not accurately obtained. It now appears that she has had an acute exacerbation of an infection of some years' standing.

No. 23 (J.A.) was a "recurrent" case needing a reopening for granulations in the mastoid antrum and residual cells in the angle of Citelli.

No. 33 (J.H.) is classified under this heading because records between seven days and two months after operation are wanting.

No. 38 (I.A.)—The first mastoidectomy broke down and only healed when the other mastoid had been opened and treated.

No. 44 (S.P.)—This child had a coexistent antral infection on the opposite side which was overlooked. Both ear and wound remained unhealed for four weeks.

No. 46 (G.B.) was primarily a traumatic otitis media, which had been treated conservatively for two months. The infective organism was *Staphylococcus aureus*, and there was a large perforation in the tympanic membrane. Ear may have been dry before it was noted, as patient did not attend between fourth and seventh week from operation.

### Summary

(1) In a series of 50 cortical mastoidectomies treated as closed abscesses, with Penicillin perfusions, 41 healed in a manner and in a time comparable favourably with more traditional methods; nine were failures from this standpoint.

(2) The method was well tolerated by the patients, and easily carried out by the nursing staff.

(3) There was a wide variety of infective organisms in the cases described.

(4) No severe complications resulted in these cases.

In conclusion, I wish to thank particularly Lady Florey for her tireless supervision and follow-up of the first series; Miss E. Oliver, the Sister-in-charge of the Department, and her nurses for their co-operation; and Drs. A. MacFarlane and W. Vollum for kindly carrying out the bacteriological investigation.

## CLINICAL RECORDS

### MALIGNANT MELANOMA OF NASAL FOSSA REPORT OF A CASE

By J. S. MONRO (New Zealand)

PRIMARY Malignant Melanomata arising within the nasal fossae are comparatively rare, and for that reason alone the case here reported seems worthy of publication. But apart from this it has the unusual features that a fatal termination did not occur until seven years after the discovery of the growth, and that except for a few cervical lymph-nodes, there were no secondary manifestations of the disease, recurrences being entirely local.

A. R. Tweedie, in reporting a case of Melanotic Sarcoma of the nose (*Journal of Laryngology and Otology*, Vol. XLVIII, p. 417) refers to an earlier article by Wilkinson in the same journal (Vol. XXVII) in which the latter author states that up to that date (1910) he had only been able to trace 10 cases. Tweedie, after having gone fairly fully into the literature, asserts as his conclusion at that time "that there would appear to be only 26 cases on record". He also states that the prospect of life is not more than four years as a result of metastasis. A large proportion of the reported cases survived for a very much shorter time, death occurring frequently within the year. Other cases of which I have been able to find reports are by K. Otsuka and W. S. McKenzie. In the first case death occurred three months later from recurrence, whilst the second was too recent to report progress upon. The period of survival in the present case, after repeated operations merely for local and necessarily incomplete removal, indicates a very low degree of malignancy, and the patient enjoyed good health and no real discomfort, except when recurrences caused nasal obstruction until removed; and no pain until toward the terminal stages. Real epistaxis, which is considered a prominent, and often an early symptom, did not occur, nor was haemorrhage in any way excessive during any of the operations.

A.P., spinster, aged 62, consulted me on June 19th, 1933, complaining of left-sided nasal obstruction of several weeks' duration. This was her only symptom apart from a little blood occasionally on blowing her nose. There was no nasal discharge and she seemed otherwise well. The patient had been under my care off and on since 1930 for other matters not related to the present condition. There was a history of her having had an "ulcer" removed by radium from the bridge of the nose several years before I knew her. Otherwise her immediate past history does not call for comment. On examination the L. nostril was found to be blocked by a smooth, rounded, firm, bluish-black tumour about the size of a hazel nut, growing by a broad base from the region of the anterior end of the inferior turbinate. The growth bled easily on probing. The nasal fossa beyond was normal, as also was the R. The R. antrum was

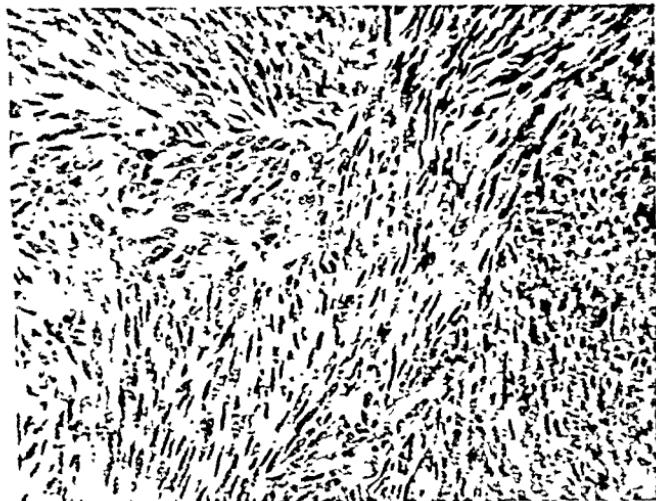


FIG. 1.  
Haematoxylin and eosin.  $\times 225$  diam.



FIG. 2.  
Haematoxylin and eosin.  $\times 550$  diam.



## Clinical Records

dark on transillumination, but there was no pus in the nose and no polypi. The diagnosis was obvious. Operation was advised, and as the patient wished to enter a particular hospital in another town she was transferred there, and came under another specialist, who operated on *July 4th*, coagulating the base of the tumour by diathermy, and also diathermizing the whole of the area of origin, which appears to be the lateral nasal wall and anterior end of inferior turbinate. This method was adopted after the pathologist who was consulted had expressed his opinion that the case was unsuitable for radium. The pathological report was "melanotic sarcoma". On *July 18th*, a second operation was performed, the whole of the L. inferior turbinate being removed. There were pigmented patches of varying size throughout the anterior. The R. antrum, which contained thickened lining membrane, was also drained. After this the patient returned to my care and was seen at regular intervals. There was no sign of any local recurrence, and it was not until *April, 1934*, that I noted the mucosa of the L. side of the septum was mottled all over with small pigmented patches of varying sizes, extending back almost to the free edge, where they appeared to be somewhat raised and larger, and tended to bleed easily. The floor and lateral wall of the nose were quite free of any pigmentation. The septal condition was watched carefully until *May, 1935*, and changed very little except for a slight tendency to increase. The patient then absented herself for nearly three years, returning in *March, 1938*, when I found a fairly large pedunculated, pigmented mass in the region of the L. middle turbinate. There was also a small hard lymph-node behind the middle of the L. sternomastoid. There was a recent operation scar in this region, the patient having had some secondary nodes removed in *November, 1937*, by a general surgeon. On *March 30th*, under evipan, I removed the tumour with cold snare after repeated puncture with the diathermy needle. It appeared to be arising from the septum far back. Diathermy was applied to all pigmented areas on the septum. The lateral nasal wall was free of pigmentation. The cervical gland was excised and proved to be definitely a secondary. Another was removed by me in *June* and a further group by a general surgeon in *July*. In *February, 1939* a recurrence was found in the region of the superior meatus, and at operation under evipan half the L. middle turbinate, which showed a pigmented area, was removed, and also masses of growth high up in the nose. The diathermy needle was applied beforehand and also to any unremoved tumour tissue. From this time on operations became more and more frequent, and were carried out whenever the patient's discomfort from nasal obstruction called for relief. Thus the advancing growth was diathermized and removed piecemeal with Luc's forceps, sharp spoons, etc., on *March 3rd* and *10th*, and *November 8th*, and in *1940* on *January 8th*, *March 13th* and *April 3rd* (by which time the tumour had spread through a large septal perforation and from now on required removal from both sides). The masses of soft tumour tissues, mostly of a bluey-black colour, but in parts unpigmented, filled the upper and posterior regions of the nose and became increasingly difficult to cope with. They appeared to be arising from the septum and ethmoid regions. There was still no recurrence anywhere near the original site. Headache became a distressing symptom during the last two months, and paralysis of ocular muscles and disturbances of vision heralded the terminal stages. Death occurred in

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coma on *September 17th, 1940*, seven years and three months after the discovery of the original growth. A limited *post-mortem* was obtained, and I am indebted to Dr. T. H. Pullar, pathologist to the Palmerston North Hospital, for the following report, and the accompanying photomicrographs.

## Pathologist's Report

*November, 1937.*—Examination of group of enlarged lymph-nodes removed from the left submaxillary region, along with the submaxillary salivary gland. These lymph-nodes had been enlarged for several months; microscopic examination showed extensive invasion of the nodes by non-pigmented metastases from a malignant melanoma. In spite of the numerous mitoses and other signs of malignant proliferation in the tumour-cells, there was a complete and fairly thick connective-tissue capsule around the growth. The central portion showed much necrosis and softening.

*July, 1938.*—Another cervical lymph-node, 2 cm. in diameter, was found to be completely invaded by the same type of secondary neoplasm; again there was a distinct fibrous capsule, the central portion was haemorrhagic and necrotic, and no melanin pigment could be found.

On numerous occasions from 1937 to 1940, portions of the melanoma removed from the nasal fossa were examined histologically. At first pigmentation was well-marked, and the tumour-cells were uniformly spindle-shaped. Later on, there were usually some portions of the growth that were almost devoid of pigment, and a tendency to more active proliferation was noted, but the cells maintained their spindle form. In the last few months, between *May, 1940* and the death of the patient in *September, 1940*, the tumour-cells became more irregular in size and shape, bizarre nuclear formations were seen, and a tendency to a peritheliomatous structure was evident. The accompanying photomicrographs show the characteristic spindle-celled structure of the tumour (fig. 1) and the deposits of melanin in parts of the growth (fig. 2).

## Autopsy

*September 18th, 1940.*—On removing the brain and inspecting the base of the skull, the only melanotic growth that could be seen was on each side of the crista galli, where the tumour had penetrated the cribriform plate of the ethmoid. The left olfactory bulb was invaded by tumour-tissue. No metastasis or direct extension of the neoplasm was found in any other part of the brain.

The pituitary gland had been pushed upwards and was abnormally mobile, the sella turcica having been destroyed, as the posterior clinoid processes and dorsum sellae were invaded by the growth. Beneath the dura in this region a collection of thick pus and necrotic growth was found; the pituitary had been, so to speak, floating on this bag of pus. More anteriorly, soft brown pigmented tumour-tissue was found. This had destroyed the upper and anterior parts of the body of the sphenoid, and also the septum between the two sphenoidal sinuses—thus forming a large irregular cavity communicating with the nasal fossae. The ethmoidal air-cells and most of the vomer had been destroyed, and a rounded mass of black growth projected into the naso-pharynx in the region of the choanae. (It was not possible to investigate the condition of the nasal fossae completely without causing disfigurement of the body.)

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The lesser wings of the sphenoid and a small part of the orbital plates had been eroded by the tumour, but the overlying dura was intact. The growth had traversed the internal walls of the orbits, destroying most of the os planum of the ethmoid on each side, but had not penetrated the orbital fascia.

No metastases were found in the remaining deep cervical lymph-nodes or elsewhere in the body; the liver contained no secondary deposits. Confluent broncho-pneumonia of purulent type was present throughout the lower lobes of both lungs, and this was the immediate cause of death.

### Commentary

One point about the case which I think is worth stressing is the manner in which the cribriform plate and the meninges withstood the prolonged threat, particularly in view of the septic condition of the nose, the abscess afterwards discovered, and the many occasions on which surgical procedures under poor visibility, were carried out in this dangerous region; and yet we are all aware of those tragedies which every now and again occur when operation for other conditions in this same neighbourhood is undertaken with the greatest circumspection and under much more favourable working conditions. The strength of the meninges, no doubt thickened as a result of chronic irritation, as a barrier to the direct spread of the growth was strikingly demonstrated at the *post-mortem* examination, and in a lateral direction the orbital fascia had proved equally effective. It is also worthy of note that there was never any recurrence at the primary site, but that after the first removal, a dissemination of pigment occurred on the septal mucosa, and this appeared to remain in a dormant state for over three years before assuming active tumour growth.

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when the patient was turned before inserting the airway. We have had no more trouble since adopting the practice of inserting the airway as the gag is removed and before the patient is turned.

- (3) Necessity for complete co-ordination between the members of the team.

## Conclusions

A safe, rapid, and reliable method of tonsillectomy under general anaesthesia with Pentothal has been evolved.

It has proved eminently satisfactory on active service, not only in buildings, but also in a wholly tented hospital.

The method requires considerable experience of Pentothal anaesthesia on the part of both anaesthetist and surgeon, and is therefore not recommended to the "occasional practitioner" in either field.

Its safety and success depend upon

- (1) The maintenance of a perfectly clear airway throughout.
- (2) Avoidance of any reflex laryngeal stimulation until the patient is sufficiently deeply anaesthetized.

Our thanks are due to Colonel G. T. Garraway, O.C. the Hospital, for permission to publish this paper.

We are grateful to Major Maxwell Telling, R.A.M.C., for his helpful advice and criticism.

## SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

December 1st, 1944

*President*—C. GILL-CAREY, F.R.C.S. Ed.

### Causes of Failure in the Surgical Treatment of Chronic Frontal Sinusitis

H. G. BEDFORD RUSSELL : I wonder how many of us could face with equanimity a parade of all our operated cases of chronic frontal sinusitis. When we meet with an acute mastoiditis we operate, and we find that in a proportion of cases every cell contains edematous membrane and no pus, but we do not on that account think that we have operated unnecessarily, and Wilde's incision is a recognition of the importance of relieving pressure. In many cases of frontal inflammation the symptoms subside, and we have a virtuous feeling at having avoided an unnecessary operation. But if the pressure has been maintained too long, the infection merely crouches for another spring when the next upper respiratory tract infection comes along ; and so on till one day the pressure can no longer subside.

If the skiagrams show haziness some months after the symptoms have subsided, chronic frontal sinusitis is already in being, as in the case of a boy of 15 who last April had right frontal pain with prolonged deafness and toxæmia. No pus was visible. Skiagrams showed the frontal sinus was hazy and the antrum was seen to contain polypoid mucosa. The antrum was exenterated, after which the deafness and toxæmia suddenly improved ; and in a recent skiagram the frontal haziness has disappeared. If it had not, surgery would have to be considered, as treatment now is far easier and better than if it were left till complete sinus-block occurred a few years later.

For many years it has been the fashionable thing to temporize with frontal sinusitis : the first step will be a submucous resection, or a reduction of the middle turbinate. Then perhaps drainage of an ethmoidal cell or palliative treatment of the antrum. I have even seen one case in which the rake's progress included submucous resection of the septum, then no less than forty antral lavages, followed by a Caldwell-Luc operation. And it often happens that there is a gratifying relief of symptoms after each step. But the symptoms may recur, and the diagnosis has to be made sooner or later ; and the later it is the worse for the surgeon as well as the patient. By this time the tissues in the infundibular region are thoroughly soaked in streptococcal juices, and the bone has been somewhat thickened by the previous operative work in the neighbourhood. Then, if the local structural considerations permit, intranasal drainage is undertaken ; and there is no doubt that a percentage of cases do well for a number of years after it, with the help of local manipulations of sorts.

Howarth has given clear indications as to the type of case suitable for an intranasal approach (*J. Laryng. and Otol.*, 1931, xlvi, 397).

Finally the case comes to exenteration, the success of which is prejudiced

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by the deterioration in local and general health which has inevitably occurred. All of which is to say that I advocate much earlier diagnosis, and open operation upon the frontal as a first step, instead of as an appendix to multiple palliative operations.

A common cause of failure is regarding the frontal sinus as an isolated offender. I regard sinusitis as originating in the diffuse inflammatory processes associated with the exanthemata, influenza, pneumonia and the like. The sinusitis is usually catarrhal at the outset, and yields to suitable palliative treatment. If children's sinuses are examined after convalescence from such illnesses, there is clinical and radiological evidence of sinusitis in a percentage of them. I recall one case following measles in a child of 10, in which the frontal sinuses were found crammed with inflamed polypi, and there was already a frontal lobe abscess; but as there was no pus in the nose, it had been thought that he could not have sinusitis.

The diagnosis of sinusitis does not depend upon the presence of visible pus, for the tissues respond to streptococcal invasion by the production of oedema rather than pus. I have had cultures made in many cases from the submucosa of the frontal after sterilization of the surface of the membrane, and found a copious growth of pathogenic organisms in cases where no pus has been seen clinically. It is even possible to grow bacteria from the deeper layers of biopsies from the mucosa near the ostia of the sinuses—a diagnostic procedure of definite clinical value. It is important in frontal sinus cases to have anaerobic cultures: the infection in frontal osteomyelitis is an anaerobe. In one case, anaerobic cultures from the interior of a polypus grew a staphylococcus, which did not come up till the fifth day.

In cases of catarrhal inflammation which do not receive suitable palliative treatment the infection may persist after the symptoms have disappeared, to recur with increasing local damage, with or without pus, with further upper respiratory infections until the swelling happens to force recognition by the occurrence of sinus-block. So that the behaviour of a sinus in response to operative treatment is conditioned by previous tissue damage, and cut he never so wisely, the surgeon's results are, to some extent, determined by matters outside his control.

This view calls for recognition of catarrhal frontal sinusitis while the local changes are reversible, and the immediate institution of suitable palliative treatment.

Failures due to technical imperfections are largely the result of fear of damaging the appearance or the function of neighbouring organs or of causing osteomyelitis by opening up cancellous bone. The few cases of osteomyelitis I have seen have quite certainly occurred owing to a *lack* of wide exposure. A case was recently seen in which an external operation had been done through a small incision, which had failed to disclose the existence of imprisoned oedema. I have not seen osteomyelitis follow the complete removal of infected mucosa, with the ventilation which can only be achieved by a free exposure.

Cosmetic failure has been less in my cases since the avoidance of delay entailed by multiple palliative operations. On the assumption that the origin of the frontal trouble must have been a diffuse affair, an increasing number of cases have been treated by extirpation of all the sinuses upon one side at the same time.

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A median incision has been employed in over forty cases during the last six years and has been found to give satisfactory access, especially if both sides have to be examined simultaneously.

Diplopia, even of temporary duration, seems less likely to occur with wide elevation of a sheet of periosteum including the origin of the superior oblique pulley rendered possible by this approach.

Exenteration has heretofore not commended itself in the case of young subjects owing to the resulting disfigurement; but recent work by plastic surgeons offers reasonable hope that this difficulty may be overcome after a suitable interval by the introduction of fresh cancellous bone chips to restore the lost contour. Mowlem has successfully employed such grafts for restoring defects in the cranium, the mandible and the long bones, so that the method should be applicable even to large sinuses approximating to the external angular process. Osseous union with the underlying frontal remnants will obviously be desirable, and though it may be necessary to roughen any very dense cortical bone to ensure this, simple removal of the overlying layer of scar is usually sufficient. Experience will show how soon after exenteration it should be safe to insert the bone chips. With the help of penicillin and chemotherapy it might be possible in suitable cases to avoid the long wait that has seemed prudent hitherto. I report two successful cases, one of two years' standing and one of six weeks'.

Recurrence of attacks after exenteration has occurred in some of my cases, and has been invariably associated with an upgrowth of mucosa from the nose in an attempt to reline the cavity from which one had so carefully removed it. The "colonizing" habit of the mucosa is of service in the other sinuses, but in the case of the frontal the upgrowth tends to get nipped by scar-tissue in the region of the infundibulum owing to the removal of bone which is occasioned by most operative procedures with an external approach. During the last two years in an attempt to checkmate this colonizing habit, the infundibular mucosa has been invaginated into the nose and allowed to hang down as a polypus, while the wound above has been packed, its pedicle being severed a few weeks later. Cases have been observed for two years after this procedure without evidence of upgrowth of mucosa.

Skin-grafting by Ferris Smith's method was tried in several cases from 1935 onwards, and the opinion was formed that this method is not the complete solution of difficulties. The behaviour of grafts is variable. There is a tendency for the skin-graft to proliferate. Out of ten cases so treated in that year, recurrence of symptoms has necessitated reopening of the sinus in three cases. In one case the frontal sinus cavity was found occupied by a sort of cholesteatoma. In another the nasal mucosa was found to have re-lined most of the cavity. In another case there was invasion of part of the nasal cavity by a skin-graft implanted in the frontal sinus. The suggestion is made that success in skin-grafting operations depends on the fact that the skin-graft prevents invasion by mucous membrane, so permitting scar-tissue to fill the cavity. In one case of exenteration in which the wound was left open and packed for several months, there followed an ingrowth of squamous epithelium which reached as far back as the posterior ethmoids, causing crusting. It completely disappeared in about four years.

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In conclusion, I am in favour of wider recognition and palliative treatment of the catarrhal stage, which will often prevent the need for operation years later. If operation becomes imperative, it should usually consist of open operation and exenteration at the outset with avoidance of the usual series of palliative operations.

WALTER HOWARTH : Some twenty years ago I said that in my opinion the ethmoid was the key to the frontal sinus, and in the intervening years I have not seen any reason to modify that opinion. This being so, it follows to my mind that the reason why some cases of chronic frontal sinusitis do not get well after operation is because the ethmoid has not been dealt with adequately and so reinfection or recurrent infection occurs from below.

There was one specimen in the Onodi collection, No. 93.1 (illustrated in the catalogue which Mr. Layton drew up for the Royal College of Surgeons), which illustrates my meaning, as it shows a remarkable development of the labyrinth. Here is a large sinus extending laterally almost to the temporal fossa and expanding the roof of the orbit backwards towards the lesser wing of the sphenoid. The fronto-nasal duct is distorted to a chink by two encroaching anterior ethmoidal cells, and the posterior one of these has an orbital process, an orbito-ethmoidal cell. There are abnormal cells of the bulla group and others in most unusual situations. It is enough to fill one with despair should one have to deal surgically with infection in such a maze. Fortunately, however, the majority of ethmoids are much simpler, though—like fingerprints—no two are exactly alike.

Exposure of the nasal end of the fronto-nasal duct by the high resection of the anterior end of the middle turbinate is a procedure of the greatest value which undoubtedly can produce resolution in a certain number of cases of not too long duration ; but in the majority of cases simple drainage is not enough, and we must prevent reinfection. For this reason, I like to exenterate the anterior ethmoidal cells, and to do this I employ the method designed by Mosher. This begins by breaking into the cell of the agger nasi and then going backward external to the line of attachment of the middle turbinate. By this means, it is easy to clear any cells that encroach on the fronto-nasal duct and floor of the frontal sinus. All that is then necessary is to pass a series of solid metal sounds up into the sinus. No rasping or cutting in the region of the bony ring that guards the sinus should be attempted. This is unnecessary, and it will be found that the sinus now drains freely. I do not like washing out, and content myself with the passage of sounds and occasionally pass a silverwire tipped with solid silver nitrate to reduce any exuberant granulations or swollen mucosa in the neighbourhood of the ostium.

A good many of the cases referred to me have had several previous operations and some have had fistulous tracks. In these, and in cases that have not yielded completely to the intranasal operation, an external approach is advisable. I still think that the incision and method that I have long advocated gives the best exposure. I have given the transantral, infra-orbital and other routes a good trial, but I am unable to get a satisfactory exposure of the anterior ethmoidal region and the fronto-nasal duct. I like to see what I am doing, and particularly do I like to see the posterior wall of the sinus and its lateral extensions.

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When we open these sinuses it is often obvious that the reason for the failure of the intranasal and other operations is that an infected ethmoid is the cause. Naturally there is a limit to what can safely be removed by intranasal means. If the infected ethmoid is removed and free drainage assured, making a very large fronto-nasal duct by removing the nasal process of the frontal bone and the ascending process of the superior maxilla and skin-grafting this, the large majority of cases get well.

Why, in some cases, does this operation fail, and why, in others, is it an unsuitable procedure? (1) It may fail because the drainage and ventilation through the new fronto-nasal duct are not adequate. This is by far the commonest reason and is usually the fault of the surgeon. (2) It may fail when the sinus is loculated, as I well remember in one case in which later there was found to be a large loculus in the temporal region, communicating with the main sinus by a very small opening. (3) It may fail because the other sinus is infected and communicating by a hole in the intersinus septum. On several occasions, by enlarging this hole, I have drained the two sinuses into the one side. (4) It may fail because behind the sinus there is a leaking frontal lobe abscess. I have had three cases of this nature, and they may be very difficult. It is a possibility that should be borne in mind, and that is why I like to see the posterior wall of the sinus.

In what cases is a drainage operation unsuitable? One sometimes comes across long-standing cases in which there is high-grade degeneration of the mucous membrane, denuded bone, necrotic areas and fistulous tracks. Such cases are to my mind only amenable to an obliterating operation, and by far the most satisfactory of these is Riedel's. Fortunately, the cases requiring this procedure form a very small percentage. The resulting deformity is severe, but this should not influence one's judgment. In the excellent film shown by Colonel Spurling and the admirable results obtained by Colonel Canfield and Major Kane, we have seen how wonderfully the cosmetic aspect can be improved, and I am always lost in admiration at the results achieved by my colleague Professor Kilner in my own cases that require plastic surgery. It is certainly an additional comfort to be able to adopt the right surgical procedure without a qualm.

NORMAN PATTERSON said that in his opinion the large majority of cases of suppuration in the frontal sinus recovered without any surgical interference at all. He agreed with Mr. Howarth that the ethmoid was the key to the whole situation because polypi or inflammation in this region interfered with drainage. Cases of frontal sinus suppuration might be divided into three groups. The first group consisted of those in which there was little change in the mucous membrane lining the sinus. Most of those cases would get well by non-surgical treatment, aided, when necessary, by chemotherapy. There were other cases in which the mucous membrane was diseased, often associated with polypoid masses interfering with drainage, which might come within the realm of surgery. There was a third class where the bony walls were diseased; possibly a fistula was present which opened on the surface. Orbital or intracranial extensions might occur without any obvious defect in the bone. He had encountered a case where there was a subperiosteal abscess, a frontal sinus abscess, and an epidural abscess, without any gross involvement of the

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bone. The infection, however, had percolated forwards through the anterior wall and backwards through the posterior wall. The class of case in which these conditions were present—obvious disease of the mucous membrane or bony walls—should be treated by fairly extensive operation. Each case must be judged on its merits. The operation he advocated in cases where frontal sinus disease was associated with gross changes in the ethmoid was, one which made a complete exposure possible ; he intended to describe his method at another meeting. It was quite impossible to deal adequately with the ethmoidal galleries, especially if they are packed with polypi, by any intranasal method.

He had seen only one case of osteomyelitis associated with an operation for frontal sinusitis. This was a patient sent to him from the East ; after nine operations, including the removal of nearly the whole of the frontal bone, he recovered. He had seen three cases of osteomyelitis, all fatal, following operations on the antrum of Highmore.

With regard to incisions, he thought the best incision was just underneath the hairy eyebrow. He considered a median incision disfiguring and quite unnecessary. As far as diplopia was concerned, a permanent diplopia seldom occurred. Practically the only operation which he performed on the frontal sinus, if the case did not clear up by drainage, involved complete removal of the anterior wall and floor. This left a certain amount of deformity which could be remedied later by employing a fat graft ; the employment of tantalum might offer a solution of this problem.

V. E. NEGUS said that he had had a great deal of trouble with chronic frontal sinusitis during the whole of his professional career, and particularly during the war.

In acute fulminating frontal sinusitis, from practical experience he thought the solution would lie in the treatment of the maxillary sinus by lavage, together with penicillin.

In chronic frontal sinusitis he took it that they were all agreed, with the possible exception of Mr. Bedford Russell, that everything possible should be done inside the nose first before any external operation was attempted. He had strong views about that ; for example he saw a certain number of cases which had failed because the septum had not been put straight. It was impossible to expect the frontal sinus to show a satisfactory recovery if the nasal fossa on that side were much obstructed. Sometimes the maxillary sinuses or ethmoidal cells had not been dealt with properly. He would therefore make every effort to cure the patient's frontal sinusitis by intranasal treatment. He did not subscribe to the opinion that the patient must not be submitted to a second operation and that the first operation must be so thorough that the patient would not require another. He saw no objection to a second operation if this were necessary. He would reserve the external operation for cases which had failed with simpler measures.

When the patient was still left with headache and discharge due to frontal sinusitis, then an external operation was advisable. Intranasal operations to enlarge the fronto-nasal duct did not appear to be satisfactory. If the patient had received all the treatment which could be carried out inside the nose without alleviation, what should then be done ? One view was that sinuses should

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be looked upon as unnecessary, superfluous, without function, and should therefore be destroyed. The other was that an attempt should be made to restore them to their natural condition. He took the latter view. In the frontal sinus he attempted to give free ventilation and drainage by making a new and larger fronto-nasal duct without destroying or interfering with the sinus itself.

To obliterate the sinus was very difficult. Often there were pockets left which formed recurrent abscesses; he had had to reopen in these cases, lift up the skin, and put in a sac-like skin-graft. Should the lining of the sinus be removed? He thought it should not be, thus accepting the original recommendation of Howarth. The procedure seemed to be unnecessary, and a number of cases got pocketing afterwards. He had had to operate on some of the failures.

He could not see the object of the mid-line incision. It seemed to be going further away from the area one wished to approach. It was not necessary to remove the rest of the floor of the frontal sinus as was done in the original Howarth operations, but they were greatly indebted for other details of the operation. Through the opening made it was possible to get a clear view of the base of the skull, and the ethmoidal cells could be removed if they had not already been cleared intranasally, which was a difficult procedure. He did not believe that more should be done than was required, or more ciliated epithelium removed than was absolutely necessary.

Following up his fronto-ethmoidal operation, he put in a tube and a skin-graft, which should not be too large, packing, if necessary, with a small piece of ribbon gauze covered with oiled silk. After removal of the tube ten days later there should be no necessity for after-treatment, and it should be possible to pass a cannula or sound easily into the frontal sinus.

He had collected the records of 100 patients on whom he had operated by the external route. Practically all of them had had everything done inside the nose that could be done, and sometimes rather more than seemed to be desirable. He had divided the cases into two groups, pre- and post-1932, that being the year in which he had started to put in a skin-graft in every case. Of the 31 earlier cases, 10 were cured and 14 were unsuccessful. By "cured" he meant that they had no symptoms and the cosmetic result was good. Of the 14 unsuccessful cases 4 had later a grafting operation with a successful result, and 8 an obliteration operation. Seven were untraced. Of the 75 later cases, 20 of whom had undergone previous external operations elsewhere; there had been good results in 56 (the patient had been freed from headache and discharge); of the remainder 12 were untraced, and 2 were of such recent date that it was unfair to include them. The bad results numbered 7; of these 2 had to have a second graft, and 3 had obliteration afterwards. One of these cases was a neurotic individual, who committed suicide afterwards. Two others died after operation. One case had skin-grafting by someone else previously and later developed an orbital abscess which was treated by an ophthalmic surgeon. He included it only because he did an external operation; the patient died of occipital abscess. The other case which died was also not straightforward, being one of osteitis fibrosa.

He concluded by expressing the view that the operation was safe, and it had given him satisfaction.

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L. GRAHAM BROWN said that he associated himself with those who had already spoken, particularly Mr. Negus, regarding the lines of treatment of the chronic condition, but he could not help wondering why surgeons did not draw a greater analogy between the frontal sinus and the antrum, and treat them in much the same way. He differed from Mr. Negus concerning the performance of an operation on the chronic sinus when the condition was well established—the history chiefly as well as the X-ray appearances would inform one on this point. He would not hesitate in such a case to make a further extension outwards of the incision at the inner canthus if this was necessary to get a good view of the cavity of the frontal sinus. Moreover he thought it was necessary to remove a membrane which was polypoid or which was actually very thickened. The latter was in fact a "pyogenic" membrane and if it was allowed to remain a bad result would ensue since it would go on forming pus. He thought the results of removing as much of the floor of the frontal sinus as necessary for the above purposes were satisfactory. Drainage into the nose by means of a large rubber tube should be carried out for quite ten days. The opening certainly cicatrized considerably, but so did the opening into the antrum, but there remained almost invariably sufficient aperture to drain the sinus.

T. B. LAYTON said that there were two causes of failure of operative surgery other than those indicated. One was the nature of the disease and the other was the fact of operation. Lister said that inflammation tended to get well by itself if the cause of the irritation were removed, and that was the reason why drainage was such a wonderful operation against the pyogenic reactions of the mucous membrane of the sinuses. But there was another reaction and that was the polypoid reaction. The cause of this was not as yet known. He was taught that it was the result of the suppurative reaction and that it was necessary to find which was the suppurative cell and to drain that. Then the rest of the mucous membrane would get well. This was the teaching of that great rhinologist F. J. Steward ; but it was one of the few points on which his teaching was wrong. If they did not know the cause of the irritation in the polypoid antrum operative surgery would not cure it, because, after all, these operations came down to the question of drainage.

The other cause of failure was the fact of operation. If the diagnosis of frontal sinusitis were made on a headache, operation would make that headache worse, and if another operation were done it would be made worse still, while if there were a third operation that unfortunate person would probably have a headache for the rest of his life.

A suppurative sinusitis following the exanthemata was very rare indeed. The cases could be finally got well by correct treatment. Children who had had whooping-cough were examined to-day by X-rays and it was found that a very large number of them had got swollen mucous membranes in the maxillary sinus. Either that should not be labelled sinusitis or there should be an approach other than operative surgery.

MUSGRAVE WOODMAN said that most acute cases resolved under conservative treatment and he never operated at all if it could be avoided. A direct opening into the frontal sinus for drainage in the acute stage would as a rule prevent a chronic sinusitis arising. Mr. Howarth was not quite right when he said that

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if the operation failed it was the surgeon's fault. He found skin-grafting of the frontal duct a difficult procedure and one liable to fail. Mr. Layton was probably mistaken when he talked about the absence of sinusitis following exanthemata. The fact was that most of these patients were ill and in a state of depressed vitality and had not sufficient power of reaction to form pus in a sinus.

THE PRESIDENT said that he agreed with Mr. Negus as to the value, in some cases, of Kisch's operation. He had found that, owing to the limited removal of the floor there was less tendency, in this operation, to closure of the fronto-nasal opening. There were cases, however, in which complete removal of the lining membrane was essential. There were obvious advantages in an approach through the anterior wall, leaving the orbital contents intact. He would like to have heard the views of those with experience of Lothrop's operation.

BEDFORD RUSSELL, in reply, said that he agreed with the President's remarks about the taking away of the supports; that was one difficulty in operations carried out by the external approach. He had devised an aseptic drainage operation through an external incision where one removed the bone but did not transgress the mucous membrane. He operated on some of these cases twenty-four years ago and saw one of them recently, in which a cannula would pass easily into the frontal, and where there had been no return of headache.

Colonel Canfield had mentioned the question of pain persisting in spite of operation on the sinuses. He himself had had one or two such cases. They seemed at the outset to need operation, but showed no improvement in the symptoms afterwards. Colonel Canfield had said that the pain was always due to pressure, but with that he could not agree. Pressure was not present and had not been present since the operation in three of the cases in his experience, but hyperæsthesia was present. He believed that a neuritis or perineuritis of the gasserian ganglion accounted for the pain persisting after operations in these people, and he still had hopes of the neuritis subsiding.

He agreed with Mr. Layton in that he recognized suppurative and polypoid types of sinus trouble. But he disagreed with him in his poor opinion of the results of operation on polypoid cases.

A cause of failure in chronic frontal operations was that one had omitted to deal with the other frontal sinus. He agreed that prolonged pressure in the frontal was often shown by absorption of either anterior or posterior wall, and it was necessary therefore in cases of an anterior perforation to keep in mind the possibility of a frontal lobe abscess.

## Tantalum Implants for Skull Defects

LIEUT.-COLONEL NORTON CANFIELD, U.S.A.M.C.: The frontal sinus has ever been one of the most difficult regions for the rhinologist. Head pains or headache is so frequent that when it occurs the patient refers to it himself as his "sinus" or his "sinus headache". The frontal sinus must always be considered with such a complaint and to establish it as a definite aetiologic factor for the pain has taxed the ingenuity of our most intensive diagnostic methods. Even when infection exists in the frontal sinuses it may not be the cause of the symptoms. Hence patients with diseased sinuses are often

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treated by operation and receive no relief from the pain. Because of many failures to relieve pain which was thought to be due to diseased frontal sinus, I have come to believe that pain does not emanate from chronic frontal sinus infection without increased intrasinus pressure. To demonstrate this pressure, a combination of intranasal and X-ray examinations, and at times an actual trephine of the sinus wall, should give us the necessary evidence.

Having decided that the sinus must be opened, and portions of its bony wall removed to effect a cure, we have constantly before us the consideration of the post-operative cosmetic appearance of the patient. Failure to remove the infection at the first operation causes delayed healing of the wound. Excessive removal of bone causes disfiguring contours. Various methods have been designed to eradicate the disease and leave the patient happy about his scars. Methods of plastic revision of the contours by living tissue and foreign bodies have both been tried, but even so, the ideal and certain method has not yet been devised.

As I mentioned at the meeting last May (*Proc. roy. Soc. Med.*, 1944, xxxvii, 674), the element tantalum is in many ways ideal for cosmetic restoration about the head.

Major John Kane will report some actual cases of injury involving the frontal sinus for which tantalum has been employed.

LIEUT.-COLONEL R. G. SPURLING (*Senior Consultant in Neurosurgery, U.S.A.M.C.*), who showed a film of the technique of plastic repair, said that the film had been made for the instruction of neurosurgeons in the Army so that they could better restore the deformities caused by war wounds. The application of the method to the whole problem of restoration after sinus operations was Colonel Canfield's idea. Many of these war wounds had involved the frontal sinus and the base of the nose, and with tantalum it had been possible to obtain satisfactory cosmetic results. His personal experience of tantalum extended back only for two and a half years, but the first cases were reported four and a half years ago; so far as was known the results had stood up to the passage of time, and tantalum had proved to be a perfectly inert material for burying in the tissues.

The film was then projected. It illustrated one-stage and two-stage procedures as carried out at the Walter Reed General Hospital, Washington. Tantalum plates of a thickness of  $15/1,000$  in. were ideal for cranioplasty. The film began by showing the impression being taken on dental compound of the skull defect and then the various stages of the plastic operation.

Several of the cases had been reported from various clinics to have developed infection after the plate was inserted—in other words, soft tissue infection—and this had been treated successfully without disturbing the plate. In fact, at one of their hospitals the medical officer in charge had drained the brain abscess through a hole he had made in the tantalum plate, without disturbing the position of the plate in the least, and that patient had remained well during a period of three months' observation before returning to the United States. Therefore he thought that this tantalum element was a very important adjunct to surgery.

MAJOR JOHN KANE, U.S.A.M.C., then read his paper describing the use of tantalum in some cases of injury involving the frontal sinus.

## OBITUARY

### SIR JAMES DUNDAS-GRANT

With the death of Sir James Dundas-Grant one of the best known names in British Otology and Laryngology has passed into history. It is astonishing over how long a period his career extended. He had already been in general practice when he took up his specialty in 1886 and more than 50 years later he was still a prominent figure at all assemblies of throat and ear surgeons.

James Dundas-Grant was born in Edinburgh in 1854, the son of a Scottish advocate. He received his education at Edinburgh Academy and then went to Dunkirk College in France. After this he entered Edinburgh University where he took his M.A. degree in 1873 and spent some time at the University of Würzburg in Bavaria before coming to London and entering St. Bartholomew's Hospital as a medical student. He qualified in 1876, took the Edinburgh M.D. with honours in 1879 and became a Fellow of the Royal College of Surgeons in 1890. In 1879 he was appointed Surgeon to the Central London Throat and Ear Hospital an appointment he continued to hold until 1913 when, retiring under the age limit, he became Consulting Surgeon. He also held appointments at the Brompton Hospital, the Cancer Hospital and the West End Hospital for Nervous Diseases.

He was an excellent teacher and his retentive memory of cases enabled him to draw from a large variety of clinical material. He was immensely interested in instruments and invented many, of which his aural probe and the cold air douche for labyrinth testing are probably the best known. He was a prolific contributor to medical journals on the subject of ear and throat disease and a most regular attendant at meetings when he rarely missed an opportunity of intervening in debate and enriching it with something from his own experience. One of his most striking attributes was his very great knowledge of the literature of ear, nose and throat disease. Nothing seemed to escape his notice and he was always anxious to try new methods in diagnosis and treatment.

During the War 1914-1918 Dundas-Grant was otologist and laryngologist to the King George Military Hospital and to numerous officers hospitals. In 1917 he became a specialist on the Aural Council and director of the Special Aural Clinics of the Ministry of Pensions, a post he retained until 1920, when he became Senior Consultant to the Ministry and was created a Knight.

Another office in which he took particular delight was that of Surgeon to the Royal Academy of Music. He was an enthusiastic musician and enjoyed nothing more than conducting an orchestra. Dundas-Grant had many international contacts. He was an honorary member of the American Laryngological Association and also of the societies of Otologists and Laryngologists in France, Belgium, Italy and Austria. He had been President of the Section of Otology and Laryngology of the Royal Society of Medicine and of the British Medical Association.

With his friendly Scots voice, his store of learning and his interest in everything and everybody he was one of the personalities of London Medicine and dying at the age of 90 will be sadly missed by his many friends and colleagues.



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## OTOGENIC BRAIN ABSCESS

By C. A. HUTCHINSON (Bath)

THE subject of Otogenic brain abscess is one of great interest to the otologist. Probably no other condition offers such difficult problems in diagnosis, particularly as regards differential diagnosis; and medical literature has been flooded with such a plethora of details and widely divergent views, that there is real danger of our not being "able to see the wood for the trees". Accordingly it is felt that there may be justification for a brief survey of the views held by various authorities and an attempt to marshall the salient points which they stress into some sort of co-ordinated order.

### Classification

The first thing to recognize is that there are several different types of brain abscess; one type, however, to a certain extent merging into another, without any clear-cut distinction.

The two main varieties are :—

- (1) Diffuse Encephalitis ("Septic softening").
- (2) The localized abscess with a capsule.

There are, however, three varieties of this :—

- (a) A pus-containing cavity with a ragged wall of softened brain tissue.
- (b) A cavity with a thin capsule of young fibrous granulation tissue, surrounded by an area of soft, oedematous brain tissue.
- (c) A cavity, perhaps small in relation to the size of the abscess, enclosed in a capsule of dense fibrous tissue, anything up to an inch in thickness, surrounded by more or less normal brain tissue.

### Aetiology

Otogenic brain abscesses may be classified as "contact spread" and "metastatic". The vast majority belong to the first group, and the

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picture which they present is frequently obscured by other coexisting infective complications of middle-ear disease (Meningitis, Infection of the Choroid Plexus and Lateral Sinus Thrombophlebitis) ; whereas the comparatively rare metastatic abscesses are almost invariably accompanied by other evidence of generalized pyæmia. For the purposes of this article we shall confine our attentions to abscesses of the "contact spread" variety.

Ballance drew attention to the fact that there is usually a "stalk" to be found, representing the inward track of the infection, connecting the bone and the abscess<sup>1</sup> : while the depth at which the abscess lies is to some extent indicated by the facts that when it is sub-cortical, one usually finds bulging of the brain, with pallor, broadening and flattening of the exposed convolutions; whereas, when the abscess lies deeply, these characteristic appearances may be lacking.

As regards the precise route by which infection enters the brain substance : It has been remarked that the most intensive septic reaction is to be found just beneath the point at which the dura is penetrated ; and Miles Atkinson<sup>2</sup> showed that, whereas the perivascular route is the one most commonly taken, the venous route is perhaps the one most likely to be followed in connection with lateral sinus thrombophlebitis.

The abscess makes its first appearance in the "avascular zone" of white matter left behind by the central and cortical vessels after passing through the cortex and up through the base of the brain : the earliest stage being a thrombosed capillary surrounded by a cuff of white blood cells. Then follows necrosis of a limited area of brain tissue, followed by pus formation<sup>3</sup>. Secondary abscesses may connect with the cavity of the primary abscess, or be found at a short distance from it without any visible connection. Such secondary abscesses are separated from the primary abscess by cerebral substance which, while it appears normal to the naked eye, is shown histologically to be actually necrosed brain substance<sup>4</sup>. It is probable that secondary abscesses are usually, and that multiple secondary abscesses are always, formed by diffusion along a vascular route. Very exceptionally, a secondary abscess is formed by the spread of suppuration from the pia mater into the brain substance—for instance, in the depths of a fissure<sup>5</sup>.

### Bacteriology

Piquet and Minne<sup>6</sup> as the result of examining abscess contents found that the infection is usually a mixed one, but that the streptococcus tends to produce a diffuse encephalitis. McFarlan<sup>7</sup>, however, showed that the commonest organism present in the localized abscess is the *Staphylococcus aureus* (some 32 per cent. of cases, and, moreover, 27 per cent. in pure culture). His figures for streptococci were as follows :—

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Strep. pneumoniae .. .. .. ..	13 per cent.
Strep. pyogenes .. .. .. ..	8 per cent.
Strep. viridans .. .. .. ..	4 per cent.
Non-haemolytic strep. .. .. .. ..	4 per cent.
Anaerobic strep. .. .. .. ..	20 per cent.
Unclassified strep. .. .. .. ..	6 per cent.

and he points out that it is obviously unjustifiable to group all these species of streptococci together. He found, moreover, that, contrary to the erroneous view previously held, encapsulation may occur in the presence of anaerobic streptococci; and he regards anaerobic culture as an essential part of the examination of pus from brain abscess, for anaerobes may be isolated from it; and it is probable that the anaerobic abscess may have originated in a focus of lowered O.R. potential produced by a vascular accident or by aerobic organisms, which later died out<sup>6</sup>.

## Symptomatology

The symptomatology of brain abscess is not yet clearly defined, and diagnosis is particularly difficult if the infection of the middle ear or mastoid is, or appears to be, insignificant—(when an erroneous diagnosis of cerebral thrombosis or encephalitis is apt to be made)—or if suggestive cerebral symptoms develop soon after a mastoidectomy.

Ballance<sup>9</sup> and Cairns<sup>10</sup> stress the need for careful, complete and repeated neurological examination, whenever intracranial complications are suspected: the latter, indeed, going so far as to say that this examination should take precedence over mastoidectomy. The tendency to a mistake in diagnosis is increased by the facts that symptoms are slight and may be transient, while progress is slow. At the same time, the very transiency of the signs is almost diagnostic<sup>11</sup>. What is certain, however, is the fact that focal symptoms are relatively late in appearing and it is not therefore wise to wait for them. The thing to go by is the general state of the patient; and should this make it seem likely that an abscess is present, it is advisable to explore without delay<sup>12</sup>. Sometimes the onset of an abscess is indicated by an easily distinguishable symptom, such as a Jacksonian fit; more often, however, the precise time of onset is uncertain. The following table, compiled by J. S. Fraser<sup>13</sup>, gives a general idea of the most prominent symptoms and their relative frequency.

## TEMPORO-SPHENOIDAL ABSCESS

Labyrinth functioning .. .. .. ..	80 per cent.
Marked Headache .. .. .. ..	90 per cent.
Vomiting .. .. .. ..	80 per cent.
Sub-normal or Normal Temperature .. .. .. ..	53 per cent.
Bradycardia .. .. .. ..	30 per cent.
Tachycardia .. .. .. ..	47 per cent.
Drowsiness to Coma .. .. .. ..	12 per cent.
Delirium alternating with Drowsiness .. .. .. ..	24 per cent.

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## CEREBELLAR ABSCESS

Distorted balance, Nystagmus and Adiadokokinesis comprise the typical cerebellar syndrome. Vertigo is always, and constant occipital headache almost always, present from the outset<sup>14</sup>.

Cairns<sup>15</sup>, however, comments that the headache in brain abscess is frequently slight; and though it may be common at the outset, lethargy and drowsiness soon supervene and tend to obscure the picture.

Papilloœdema is shown by some patients, but it may be almost or completely absent. Examination of the visual field is most important, but as the co-operation of the patient is needed it becomes impossible once he has become lethargic.

Suggestive transient signs are:—wrist drop lasting a day or two, a little opposite lower facial palsy, and transient ocular paresis.

Lastly, Lambert Rogers<sup>16</sup> has drawn attention to what he calls the "Posterior Fossa Compression Syndrome", in which the patient collapses and respiration stops, while the heart continues to beat vigorously. This indicates the presence of a sudden subtentorial rise of pressure, due to either haemorrhage, tumour or abscess; and demands, if it is not to become rapidly fatal, rapid posterior fossa decompression and the simultaneous administration of oxygen, either *via* an intra-tracheal catheter or an emergency tracheotomy or laryngotomy.

## Differential Diagnosis

The diagnosis, and in particular, the differential diagnosis, may be extremely difficult. A glance at the symptomatology will show the most constant symptom to be headache; and indeed, one may take it that persistent headache following a mastoiditis or a mastoidectomy is a definite danger signal and demands that, at least, a very careful watch should be kept on the patient.

The enormous recent strides in chemotherapy have greatly improved the prognosis in middle-ear disease, but the universal adoption of these drugs has tended to obscure the diagnostic picture and lull us all too easily into a sense of false security. In a brief article by the author in the *Brit. med. J.* for August 2nd, 1941<sup>17</sup> he pointed out how the indiscriminate use of sulphonamides, particularly if in inadequate dosage and over an insufficient period of time, can mask a "Mastoiditis": several months to some months later there may be signs of the development of some intracranial complication; but thanks to the sulphonamide already used the middle-ear signs may be so trivial at the moment, or forgotten in the past, that great difficulty in diagnosis occurs. Another cause for such difficulty is the pernicious "Mucosus Otitis", which tends to show a greater incidence of complications than other middle-ear infections,

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and in which the initial clinical course may be so mild that the patient may not even have sought advice.

It should be noted that temporo-sphenoidal abscess may be closely simulated by purulent pachymeningitis following a mastoiditis; and a cerebellar abscess may sometimes be confused with a serous meningitis or arachnoiditis<sup>18</sup>; while both meningitis and cerebral or cerebellar abscess may coexist. A careful history and neurological examination, however, should enable a distinction to be made.

Differential diagnosis mainly lies between brain abscess (cerebral or cerebellar), otitic hydrocephalus and meningitis: other possible alternatives being intracranial tumour and haemorrhage into the posterior fossa. What therefore are the principle differential points? In all these conditions there tend to be in varying degree, the classical signs of rising intracranial pressure, i.e. headache, vomiting and papilloedema; while Lambert Rogers<sup>19</sup> has drawn attention to the important posterior fossa syndrome, indicating a sudden sub-tentorial pressure rise acting on the more vulnerable respiratory centre: such pressure rise, however by its very suddenness suggesting haemorrhage rather than the other alternatives.

### Certain Diagnostic Inferences which may be drawn from Lesions found at a Previous Operation

(1) The finding of an extradural abscess during a previous operation, in a case which later presents vague cerebral symptoms, should awaken the suspicion either of a localized meningitis or brain abscess; as experience shows that associated intradural suppuration is present in a considerable proportion of cases of extradural abscess.

(2) The presence of osteomyelitis involving the squamous portion of the temporal is always suggestive of an underlying localized meningitis.

(3) Mastoiditis with labyrinthitis is a frequent forerunner of meningitis or cerebellar abscess.

(4) Mastoiditis with labyrinthitis and an associated sinus thrombo-phlebitis is especially apt to be followed by cerebellar abscess.

Lastly, in the case of mastoiditis the patient does not look sick until the terminal stage of blood-stream infection, although recording high temperatures with or without accented "swings". He is apt to present an appearance of well-being—apparently too well in proportion to the temperature recorded. This favourable impression is on the whole a good prognostic sign, and as long as the pulse-rate is proportional to the temperature the prognosis remains favourable; but an ascending disproportionate pulse is often the earliest sign of complicating meningitis.

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## Valuable Diagnostic Points

	<i>Meningitis</i>	<i>Otitic Hydrocephalus</i>	<i>Brain Abscess</i>
1. Optic Disc	Usually slight swelling.	Enormous swelling (Several Diopters).	Commonly slight swelling, but more usually only slight venous engorgement.
2. Temperature	Continuous Hyperpyrexia.	Apyrexia.	In the majority of cases Subnormal or Normal.
3. General Condition	Irregular attacks of Delirium.	Between attacks of Headache and vomiting, alert, lively and of good appetite.	Dull, constipated, no appetite.

Examination of the cerebrospinal fluid by lumbar puncture and the results of manometric readings are of the utmost value.

	<i>Meningitis</i>	<i>Otitic Hydrocephalus</i>	<i>Brain Abscess</i>
A.	Moderate to high C.S.F. pressure.	Very high C.S.F. pressure (neighbourhood of 300)	Less high C.S.F. pressure (150-250)
B.	Opalescent to Turbid.	Clear.	Frequently Turbid.
C.	Reduced Chlorides and Sugar in C.S.F.	Normal Composition of C.S.F.	Never normal composition of C.S.F.
D.	Excess Protein; White Cells raised; and frequently organisms.	No excess of Protein or Cells.	Always slight excess of Protein; usually slight excess of Cells (Mainly Lymphos. and a few Polys.; no organisms).

It is evident from the above that the diagnostic value of lumbar puncture cannot be over-estimated.

Two points of definite value for differential diagnosis are :—

(1) The presence of the Gradenigo Symptom Complex—consisting as it does of pain deep in the head, usually localized above the ear and/or deep within the orbit of the same side, accompanied by a low cerebrospinal fluid cell count and at times by paralysis of the external rectus of the homolateral side, coming on as a rule several days or weeks after a mastoiditis—indicates a meningitis secondary to a petrositis and *not* an abscess within the substance of the brain. It should be noted, however, that, occasionally, a brain abscess may co-exist.

(2) If at operation pus is found when a little cut is made in the dura, it is almost certain that there is *not* a brain abscess.

## Course and Spread

A spreading abscess tends to make its way towards the ventricle ; or rather perhaps, the ventricle filled with cerebrospinal fluid under pressure (due to toxic irritation of the choroid plexus and resultant over-secretion) tends to herniate into the softened brain ; in which case the accident, not necessarily fatal, is indicated by the escape of cerebrospinal fluid from the wound<sup>20</sup>.

Piquet and Boury<sup>21</sup> pointed out that the progress of an abscess towards the ventricle varies considerably. In some cases the abscess grows slowly

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and the ventricle becomes reduced to a mere slit, or perhaps occluded altogether by the formation of a homogeneous mass containing a few fibrils. In other more quickly growing abscesses, however, an irruption into the ventricle causes sudden death.

Dan McKenzie<sup>22</sup> pointed out that a brain abscess may rupture spontaneously and gradually discharge, either internally into the ventricle or externally into the meningeal spaces; and Cairns and Donald<sup>23</sup> stressed the fact that abscesses may leak into the lateral ventricles or subarachnoid space without producing fatal diffuse leptomeningitis.

In most cases of external rupture the pus travels by the route through which the infection entered the brain, the tissues there being devitalized and in some cases disintegrated. The relief afforded by leakage is rarely sufficient to neutralize the pressure effects of a brain abscess, or to keep its bulk from enlarging, or the infection of the brain from extending. Rupture into the ventricle, it should be noted, may occur in spite of the coexistence of a leak<sup>24</sup>.

Lastly, the temporo-sphenoidal abscess is apt to grow to a larger size and to be quickly fatal after rupture, whereas the cerebellar abscess appears to be much more amenable to treatment.

## Localization

Localization of the abscess is often very difficult indeed, as focal signs appear comparatively late; in fact the whole of one cerebellar lobe may be practically completely destroyed without there being either Arm Deviation or Past Pointing. A further complicating factor is the drowsiness of the patient, which comes on relatively early, making it still more difficult to elicit localizing signs. Accordingly, whereas McConnell<sup>25</sup> stated that he thought it essential to localize the abscess before anything is done, the general concensus of opinion nowadays seems to be that it is not wise to wait for localizing signs at all but to be prepared to explore the brain with much less evidence than that which has been insisted upon up to the present. It must be repeated that complete and repeated neurological examination, together with careful history-taking, are of the utmost value.

Terence Cawthorne<sup>26</sup> emphasizes the value of investigating cochlear function—for a generalized loss of cochlear function indicates that the lesion causing it does not lie within the brain, but must either involve the VIIth nerve trunk or be located in the labyrinth; while, on the other hand, an alteration of vestibular function in the presence of a normal cochlear response always means a lesion within the brain tissue, usually in the posterior fossa and often in the brain stem.

Cerebellar abscesses are apt to give earlier indication of their presence<sup>27</sup> than do abscesses in the cerebrum itself, because of the ventricular distension which they tend to produce. Hypotonia and

ataxia further suggesting such cerebellar localization, particularly in the presence of the typical cerebellar syndrome of distorted balance, nystagmus, and adiadokokinesis.

The value of nystagmus itself for localizing purposes is very slight. Vertical nystagmus is said to be always of central origin and is also seen in a brain stem lesion. Lastly, a brain stem lesion (e.g. a cerebello-pontine angle tumour) shows slow and coarse nystagmus on looking towards the side of the lesion but fine and rapid nystagmus on looking towards the sound side<sup>28</sup>.

Visual aphasia is a very important localizing sign in left-sided temporal lobe abscesses; but does not help in the case of a lesion involving the right temporal lobe, except according to some authors, in the case of a left-handed patient, when it *may* be present.

Radiological examination is of some use since the abscess very often contains gas, which is revealed by the radiogram<sup>29</sup>.

When an abscess is suspected in one or other cerebral hemisphere<sup>30</sup> exploratory ventricular tapping is valuable, for the ventricle is always collapsed on the side of the abscess and is normal or slightly larger than normal on the opposite side. A ventriculogram is of still further assistance, in that it shows the presence of air on the sound side and its absence in the ventricle on the side involved. McConnell, indeed, advocates ventricular puncture in all cases as a preliminary to actual exploration of the brain; particularly in view of the facts that, while in the majority of cases the brain lesion lies on the side of the infected ear, in a small percentage of cases (metastatic spread) it may lie on the opposite side; and there is always difficulty in deciding which side the abscess lie when both ears happen to be infected.

In the present state of our knowledge, however, exploration of the brain is the only way in which a number of these abscesses can be definitely located.

## Treatment

A. *The Principles.*—At present the essential treatment is surgical but the prognosis must always be extremely grave<sup>31</sup>. While the primary object is the effective drainage of the abscess, one must always bear in mind the fact that precocious or misdirected surgical measures may well result in fatal complications or, at least, involve risk of serious damage to brain function.

The surgeon, therefore, should start with a clear idea of what he wants to do and should handle the brain gently.

Neumann<sup>32</sup> advocates exploratory puncture as soon as the general state of the patient gives reason for suspecting that abscess is present. The risks entailed by undue delay (rupture into the ventricle; rapid onset of cerebral compression; development of cerebral oedema; and

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in the case of cerebellar abscesses in particular, sudden respiratory failure) being too great. The aim should be to operate in such a way as not only to save the patient's life, but also to prevent permanent crippling: at the same time, in such a dangerous condition it is a mistake to operate too timidly.

B. *Choice of Procedure*.—First try and decide which variety of abscess it is with which you are dealing, for measures clearly right for one variety may be absolutely wrong for another; and as Neumann points out, each abscess needs its own special method of operation and a uniform treatment can never be successful<sup>33</sup>.

Cairns<sup>34</sup> states that it is doubtful whether abscesses in the acute stage should be operated on, but admits that occasionally this might have to be done. In his opinion the treatment of chronic abscesses (of moderate duration) should be to leave the wall of the abscess alone and drain the cavity. He emphasizes, however, that very chronic abscesses of long duration cannot be treated successfully by drainage, because the thick wall of hyaline fibrous tissue would never collapse completely or be entirely absorbed: while abscesses of such chronicity have a strong tendency to loculation, therefore enucleation should be carried out.

Guns<sup>35</sup> is of the opinion that the treatment of an acute cerebral abscess by aspiration is not ideal and carries a high mortality rate. He considers drainage of a cerebral abscess to be the procedure of choice, and holds that enucleation of the abscess should only be carried out in exceptional cases.

To summarize modern opinion therefore:—

For diffuse encephalitis (type 1) no surgical treatment is likely to be of any use except perhaps a simple decompression. When necrosis with pus formation has occurred (type 2) drainage may be undertaken with some hope of success. For type 3, embracing almost all otogenic cases, drainage is indicated. For type 4 (the very chronic thick-walled abscess), however, the proper treatment is not to drain but to enucleate the abscess and close the wound.

C. *Technique*.—The rules governing the opening of the abscess are (1) not to interfere with any protective adhesions of dura, arachnoid and pia, which may have already formed around the region through which the abscess is to be opened; and (2) to deliberately cause adhesions to form round it, should none already exist. If the "stalk" can be found, representing the inward track of the original infection and connecting bone and dura, it obviously affords the ideal route of approach: but if no "stalk" can be found the transarachnoid route must be adopted. In either case the bony opening need not be a large one, as the evacuation of pus will be followed by a fall in intracranial pressure; moreover, as Bozzi<sup>36</sup> points out, if a wide dural opening be made some encephalitis is set up and herniation of the brain is apt to follow.

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There is some difference of opinion as to the best technique to adopt for exploring for abscess. For instance, Sargent<sup>37</sup> advised against the use of trocar and cannula ; since these may pass by the capsule or, on the other hand, may fail to penetrate it but push it inwards and cause it to burst into the ventricle. He therefore favoured exploration with a small, flat seeker, which passes with the minimum of force through the softened brain tissue and permits easy recognition of the resistance afforded by an abscess-capsule ; and if by any chance it penetrates into a thin-walled abscess, pus at once flows out along it. Cairns, on the other hand<sup>38</sup>, reminds one that one must be prepared to explore over a wide field and therefore prefers exploration with a brain needle.

As regards the technique for opening and draining the abscess once it has been located and its depth ascertained, there is again some disagreement. The older school were in favour of tying off such cortical vessels as may be necessary and then incising the abscess cleanly with a sharp scalpel. Cairns, however<sup>39</sup>, prefers to employ close drainage for relatively deep-seated abscesses-as are most temporo-sphenoidal otogenic ones. When the abscess, however, is very near the surface he enlarges the bony and dural openings and incises the abscess as usual with a scalpel ; for close drainage he inserts a rubber catheter ; but sometimes the tip of this will not penetrate the abscess capsule. In this case, if the condition of the patient is not extremely urgent, it is best to leave the catheter tip in contact with the capsule for a few days ; then when the next dressing is done it will be found that some capsular erosion has been produced and it is possible to get in. If, however, the patient's urgent condition in the first place indicates immediate drainage, a firmer catheter or a stylet-strengthened one should be used.

The above procedures, however, only apply when exploration and drainage are done in the region of a "stalk ". When the transarachnoid route is adopted one should remember that with the evacuation of pus the resultant fall in pressure will be immediately followed by a collapse of the brain tissue from the surface, and the consequent opening up of the sub-arachnoid space : a two-stage procedure is therefore advisable. At the first stage the sub-arachnoid space is shut off by packing round the selected area with gauze strips (plain or moistened with 1 per cent. tincture of iodine) and leaving this *in situ* for 48 hours ; (if necessary aspirating some of the abscess contents at the time). The second stage of actually incising and draining the abscess can be then carried out with a far greater margin of safety.

The precise material for the drainage tube is of little importance. Rubber is rather too bulky for the size of the bore but it serves the purpose well enough. Aluminium or celluloid tubes have the advantage of larger bore ; while decalcified bone tubes have their advocates, including Macewen. The tube should be sutured to the edge of the dura or the

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skin. Lemaître and certain Danish clinics employ filiform drainage tubes : these work well at first but tend to become insufficient during the course of treatment.

The healing of an abscess must not be looked upon as a definite condition ; there is not sufficient tissue material for the solid cicatrization of any great defect in brain substance, so that it is possible for one part of the resulting cavity to heal as a solid mass, while another part forms a cyst, and sooner or later, perhaps years after, this may become reinfected by an acute exacerbation, and there occurs what must be regarded as a relapse of the abscess<sup>10</sup>.

When an abscess has been properly evacuated and drainage established the intracranial pressure falls, provided no complication, such as meningitis, encephalitis or a second abscess, exists. The appearance of a "Fungus Cerebri", however, means that the intracranial pressure has not been relieved. A "Fungus" must be clearly distinguished from a "Hernia Cerebri", for, whereas the latter means a protrusion of healthy brain, still covered by the pia, arachnoid and skin, with its circulation and functions unimpaired, the "Fungus" is a protruding mass of strangulated, necrosed and functionless tissue indicative of comparative failure to relieve intracranial pressure. If the brain protrudes persistently or increasingly, either the abscess is insufficiently drained or some complication (such as a second abscess or meningitis) may be present. It is unwise, however, to interfere locally too soon, as there is always some œdema, which tends to push the tube out, and this period can be tided over by withdrawing fluid from time to time by lumbar puncture<sup>11</sup>.

## After-Treatment

The after-treatment of acute or chronic abscesses is the same, whatever method of drainage be employed. Dressings should only be done at long intervals ; it being borne in mind<sup>12</sup> that meddlesome interference after evacuation of the abscess (too frequent dressings, washing out with antiseptic, and packing the abscess cavity with gauze) all tend to produce the very thing it was desired to avoid. The first dressing should be left undisturbed for as long as possible, usually a week to ten days. It should be done in the operating-theatre and by the surgeon who drained the abscess. The tube is not removed at dressing, but must be kept clean by very gentle syringing. It should be retained in place at least until all tendency of the brain to herniate has disappeared and then shortened very gradually before being finally discarded. The next important factor is prolonged rest in bed.

## Complications during After-Treatment

Rise of temperature is almost invariable. The really important post-operative complication is post-operative œdema. If the tube had gone

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into the abscess cavity in the first place and oedema subsequently develops the right thing to do is to leave the patient alone and *not* interfere. Squints seem quite common after abscess but apparently are not of serious importance. Fits during the first week of convalescence may occur. Undoubtedly epilepsy may be a disappointing complication of an otherwise successfully treated brain abscess. It has probably according to Cairns nothing to do with the actual treatment<sup>43</sup> but is due to a pre-existent inherent tendency. Lastly, the partially subsiding abscess during convalescence should be most carefully watched for it is likely to erupt rapidly like a volcano.<sup>44</sup>

In conclusion, it should be stated that the question of chemotherapy in connection with the treatment of otogenic brain abscess has been purposely omitted since the whole question is still more or less in the experimental stage. It is certain, however, that chemotherapy will come to play an increasingly important part and that in the future we may confidently look forward to results which could never have been hoped for or dreamed of in the past.

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# UNUSUAL INTRACRANIAL COMPLICATIONS OF OTITIC ORIGIN REPORT OF THREE CASES

By E. G. COLLINS (Major, R.A.M.C.)

DURING the year 1941, there were seven patients with intracranial complications of otitic origin in a General Hospital in the Middle East. Three of these cases, on account of the unusual features they presented, seem of sufficient interest to merit further discussion.

## CASE I.—*Spreading Thrombosis of the Cerebral Sinuses following Acute Mastoiditis.*

L/Cpl. L. was admitted on 3.5.41 with a history of pain in the left ear, which had started fourteen days previously whilst he was on board ship in a convoy. For about ten days the ear had been discharging profusely, and for two days there had been some swelling behind the ear. No history of previous aural trouble could be obtained. On examination he showed the classical symptoms and signs of acute mastoiditis and I performed a cortical mastoid operation on the evening of admission. Extensive infection of a pneumatic type of mastoid was found with granulations present on the lateral sinus and small granulations over the dura of the middle fossa. No further exploration of the lateral sinus or dura was made at that time, but the wound was left open and packed. From the pus in the mastoid cells a micrococcus catarrhalis only was cultured, though it seems probable that a staphylococcus or streptococcus was present.

Progress during the next week was fairly satisfactory, though the patient was emotionally unstable, with crying fits and brief periods of mental confusion. Often, it was difficult to arouse his interest but no dysphasia was present. The temperature, which had been 101.4°F. on admission, remained subnormal and the pulse was rather slow. I asked Major Ian Gordon, the Medical Specialist, to examine him and he considered that there was no gross meningeal involvement but that some cortical involvement was possibly present as the reflexes were exaggerated. Vomiting occurred about the tenth day, and the possibility of a brain abscess was naturally considered but there were still no localizing signs and Major Cockburn, the Ophthalmologist, reported the eye examination entirely negative. A lumbar puncture was done but gave no additional help—the cerebrospinal fluid was not under pressure, cells were 4 per c.c., proteins 35 mg. per cent., chlorides 804 mg. per 100 c.c. and culture of the fluid was sterile. It appeared justifiable to adopt an expectant attitude, though a course of sulphapyridine was started.

On the twelfth day after operation there was an evening temperature of

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102°F. and this was followed next day by a rigor and a temperature of 106°F. On dressing the mastoid, I found the cavity flooded with pus and there seemed little doubt that a pyo-thrombosis of the lateral sinus was present. As is so often the case, the patient made no complaint and was, in fact, rather brighter and more co-operative than he had been previously. Under an anaesthetic, I made a complete exposure of the lateral sinus from the genu to near the jugular bulb and observed the pus to be oozing from a sloughing area in the centre of the lateral sinus which was covered by some rather flabby granulations. The sinus was slit up along its entire length and the thrombus evacuated. Free bleeding was obtained from both ends and the sinus was obliterated at each end by BIPP gauze packing. In view of the necessity of excluding a brain abscess I also applied diathermy to the dura of the middle fossa and explored the temporo-sphenoidal lobe with a needle, but the result was negative. A blood culture taken at that time was sterile but in spite of this the sulphapyridine course was continued.

For the next fortnight the condition of the patient improved. The tongue was more moist and the temperature and pulse returned to normal, but the general air of lethargy and lack of interest was still pronounced.

At the end of a month definite signs of deterioration set in. Attacks of mental confusion amounting to semi-coma became frequent. Such an attack lasted 4-5 days and was accompanied by frequent incontinence of urine. Great difficulty was experienced in coaxing the patient to drink. Rectal salines were not retained and resort to an intravenous drip was necessary. The temperature was now rather irregular but any rise responded promptly to the exhibition of sulphapyridine. Further blood cultures were sterile and a repeated exploration of the temporo-sphenoidal lobe was again negative. No changes in the fundi could yet be detected nor could I find any other localizing sign on repeated examination, though there was an occasional complaint of headache. I should emphasize that these attacks of coma were intermittent and alternated with periods of lucidity and co-operation.

I had come to the conclusion that there was an upward spreading thrombosis of the lateral sinus, and about the sixth week of his illness I was fortunate enough to obtain the collaboration of Lt.-Col. Ascroft, who had recently arrived at the hospital with his Neuro Surgical team. For the first time some hemianopia could be demonstrated on the right side with papilloedema. A left-sided positive Babinski was also now present. Further lumbar puncture showed the cerebrospinal fluid was under 60 mm. pressure, cells 3 per c.c. and protein less than 10 mg. per cent. Lt.-Col. Ascroft suggested the diagnosis might be helped by an encephalogram and he carried out a cisternal puncture replacing 30 c.c. of cerebrospinal fluid by air. No space occupying lesion could be demonstrated by X-ray in the left cerebral hemisphere, nor was any dilatation of the ventricles seen. This slow and lingering illness dragged along and was finally terminated by a broncho-pneumonia on 6.7.41, nearly nine weeks after admission.

## Post-Mortem Report

"The body is wasted and dehydrated. The cavity of a cortical mastoid operation is present on the left side of the head.

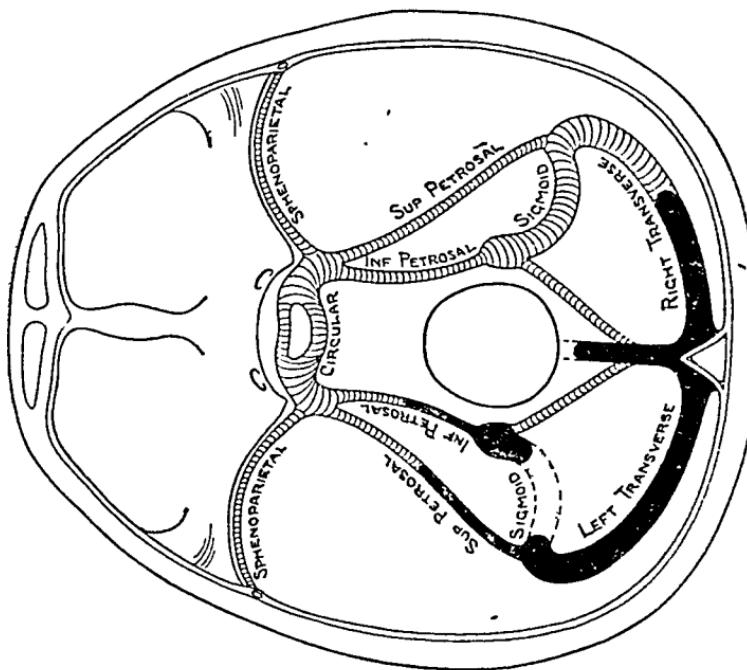


FIG. 2.

Basal view of Venous Sinuses, showing extent of Thrombosis ; stippled area indicates part cleared at operation.

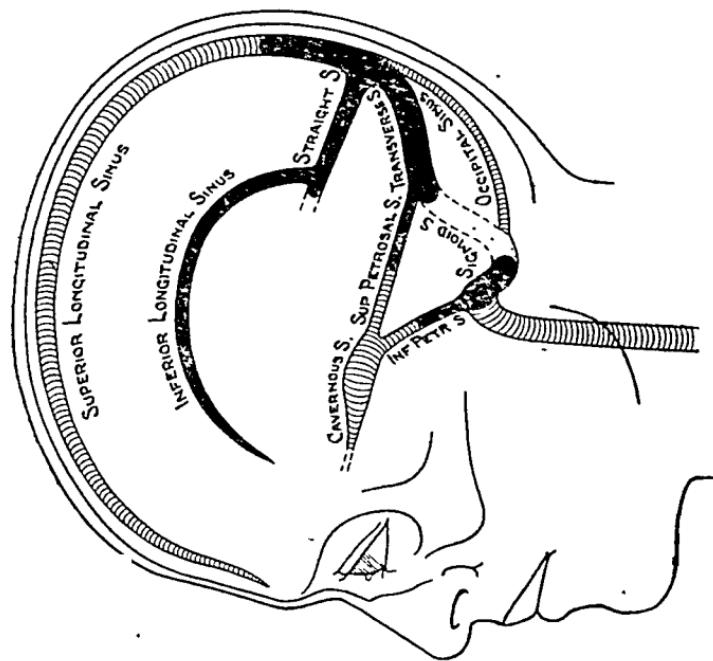


FIG. 1.

Left Lateral view of Venous Sinuses, showing extent of Thrombosis ; stippled area indicates part cleared at operation.

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## MACROSCOPIC

(1) *Dura Mater and Sinuses.*—The *superior longitudinal sinus* is healthy for the greater part of its extent. Owing to a congenital abnormality, it opens equally into both the transverse sinuses, and at the confluence of the sinuses, the posterior extremity of the *superior longitudinal sinus* contains an ante-mortem clot. This thrombus is continuous with a progressively liquifying thrombus throughout the *left transverse sinus*. Most of this clot is frankly purulent. The walls of the *left transverse sinus* are thickened and furred with unhealthy granulation tissue. Where this sinus becomes known as the *left lateral or sigmoid sinus*, the outer wall is deficient and the lateral sinus is sealed off by a thrombus at its upper and lower ends. The *left superior and inferior petrosal sinuses* contain hard ante-mortem thrombi. The *inferior longitudinal sinus* contains a suppurative thrombus throughout its entire length. The *right transverse sinus* contains a recent thrombus extending from the confluence of the sinuses. The *left jugular bulb* and vein are free from thrombus as is also the cavernous sinus.

(2) *Brain.*—The left temporo-sphenoidal lobe is lightly gummed to the dura in the region of the *left lateral sinus*. There is no sign of gross meningitis. The brain on section is rather oedematous and the white matter is universally congested, but there is no evidence whatsoever of brain abscess formation.

(3) *Thorax.*—At the outer margin of the lower lobe of the left lung is a sub-pleural abscess 1 in. in diameter. Both lobes show well-marked broncho-pneumonia and the upper lobe shows early consolidation of a lobular type. The pericardium is gummed to the heart by a thick fibrinous exudate. The other organs in the body are normal in appearance.

## MICROSCOPIC

*Left transverse sinus.*—Chronic sepsis has transformed the dural walls of the sinus into a thick layer of granulation tissue with the disappearance to a considerable extent of the original architecture. The innermost surface is coated thickly with polymorphonuclear leucocytes.

*Brain.*—In the grey matter the nerve cells have disintegrated and the neuroglia has lost some of its staining properties. In the white matter similar degenerative changes have occurred. A striking feature is the width of the Virchow-Robin spaces, indicating chronic cerebral oedema. In many areas perivascular leakage of blood cells has occurred. A few areas are observed with increase in small round cells, but on the whole there is no unequivocal evidence of inflammatory changes. The meninges are healthy and the cerebral vessels are not thrombosed."

## Comment

Retrograde thrombosis of the lateral sinus is uncommon, though thrombo-phlebitis of the cavernous sinus has been recognized for many years as a possible complication of otitic sepsis. Jansen (1893)<sup>13</sup> first drew attention to this source of origin and cases have been recorded by Uta,<sup>22</sup> Dwight and Germain (1902)<sup>6</sup>, Ritchie Rodger (1921)<sup>18</sup>, Brunner (1926)<sup>2</sup>, Eagleton (1927)<sup>8</sup>, Druss (1942)<sup>7</sup> and others. In nearly all the cases the infection has travelled *via* the petrosal sinuses or carotid plexus of veins, and, in the majority, the illness proved fatal within a few days. A review of the literature has failed to disclose the report of a case where the slow strangulation of the cerebral venous circulation by multiple sinus thromboses could be observed clinically over a fairly lengthy period such as occurred in this patient. It was an unhappy experience as one felt there was so little that one could do. By the time the diagnosis was reasonably certain the patient was in no condition to stand further operation. Yet, if I had explored the transverse sinus at an early stage, it is possible the patient might have survived. The clinical account which has been given illustrates the difficulties that must arise in making a differential diagnosis between cerebral oedema and cerebral abscess. Perhaps the most helpful procedure in excluding the latter condition is the encephalogram, but even this has its limitations. Another point of interest is the absence of intracranial hypertension. The pressure of the cerebrospinal fluid was never higher than 60 mm. and there was no hydrocephalus. Ophthalmic changes were also late in making their appearance. Both Symonds (1937)<sup>21</sup> and Levy (1939)<sup>15</sup> have postulated a thrombo-phlebitis of the dural sinuses as an explanation of the aetiology of otitic hydrocephalus. The former believes this leads to a dilatation of the ventricles and subarachnoid spaces, but the latter points out that such a dilatation has not been observed in pneumographs, and considers that an intracerebral oedema is the more probable explanation. The results of the histological examination made in this case support the latter contention, and the absence of hypertension in my patient may be due to the fact that the venous stasis took place so gradually. It is rather remarkable that the cavernous sinus escaped. One must conclude that the thrombi in the petrosal sinuses were relatively aseptic as was also the thrombus which occluded the lower end of the lateral or sigmoid sinus.

CASE II.—*Spontaneous Rupture of the Lateral Sinus following Acute Mastoiditis.*

A Senior Officer in the Army was blown up by his car going over a land mine in the Western Desert. He sustained a fractured astragalus and was subjected to a considerable amount of blast to the right side of the head. I saw him about a week after the incident when he stated that for three days there had been considerable pain and discharge from the right ear. On examination, I found an acute otitis externa with stenosis of the external meatus making it impossible to see the tympanic membrane. The character

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and extent of the discharge, along with some slight pulsation that was present, indicated probable middle-ear involvement. No real mastoid tenderness was found but he was admitted for observation and further investigation on 12.5.41. Though the otitis externa improved with treatment, the discharge remained profuse and throbbing pain was still present at the end of ten days. X-ray of the mastoids revealed clouding of the cells on the right side with no cell disintegration. There was a slight evening temperature of  $100\cdot2^{\circ}\text{F}$ . and since no improvement in his aural condition had taken place, he was started on a course of sulphanilamide. At the end of three weeks, fairly severe hemi-craniad headache with temperature and free aural discharge still persisted, and I decided to carry out a cortical mastoid operation, although there was still no mastoid tenderness. I found a thick cortex covering a diploic type of mastoid with granulations on the dura of the middle fossa and some small granulations of the lateral sinus, which otherwise appeared healthy. There was a moderate amount of pus in the mastoid cells and this grew a hæmolytic streptococcus.

During the next week progress was not entirely satisfactory. The patient still complained of headache with slight giddiness. Occasional attacks of nausea and vomiting were present but I considered this to be due to the sulphanilamide. Immediately this drug was withheld a rise of temperature with a rigor almost invariably followed. Various laboratory examinations were made during this period.

*Lumbar puncture.*—The cerebrospinal fluid was not under pressure. Cells were 3 per c.c., protein 45 mg. per 100 c.c., and culture sterile.

*Blood examinations.*—A slight leucocytosis was present. Polymorphs were 85 per cent., Lymphocytes 15 per cent. and Monocytes 2 per cent. No malarial parasites were seen in the blood films. This last examination was important as the patient had suffered from a severe attack of malaria a year previously when he was in India. Blood culture was positive for hæmolytic streptococci.

There was thus little doubt that a hæmolytic streptococcal septicaemia was present, but the question remained as to whether there was a true sinus thrombosis. It was with some trepidation that I decided against opening the sinus and ligaturing the jugular vein, but the sulphanilamide appeared to be controlling the condition well, and by now the patient's condition was improving.

Exactly a fortnight after the mastoid operation, and nearly six weeks from the start of his illness, I received an urgent call to the ward on account of profuse bleeding from the lower end of the mastoid wound. The soft rubber drain that was present was hurriedly removed and I packed the cavity with ribbon gauze. Under an anaesthetic, I opened up the wound and found the blood to be gushing from a small hole in the centre of the lateral sinus. Over this I placed a piece of temporal fascia which soon stopped the bleeding. The mastoid cavity was left open and packed with Eusol gauze. In spite of sulphonamide therapy, the temperature started to swing rather violently. A blood transfusion with intravenous sulphanilamide was given, but nine days later the temperature rose to  $106\cdot6^{\circ}\text{F}$ . accompanied by a rigor and was only controlled by sponging with iced water. This marked the culminating point in the patient's illness, and slow but steady improvement followed. The

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haemoglobin which had been down to 60 per cent. rose to 85 per cent. and with a further transfusion of three pints of whole blood it practically reached normal. The administration of sulphonamides was continued for ten days longer and gradually the temperature returned to normal.

Eventually the mastoid wound was re-sutured and the patient was discharged from hospital on 12.8.41, three months after his admission. By this time the middle ear was dry, the otitis externa had completely cleared and there was a linear perforation of the tympanic membrane present. This finally closed for, on re-examination at the end of three months, I found the tympanic membrane and hearing were both normal. Altogether the patient received 55 grammes of sulphanilamide and 25 grammes of sulphathiazole.

## Comment

This patient certainly owed his life to chemotherapy. Whether it would have been wiser to occlude the sinus and ligature the internal jugular at an early stage will be a disputed point, but in my opinion, if there is an absence of pyæmia such a procedure is unnecessary. In this type of case it is a generalized blood septicæmia with which one has to deal, and not a localized thrombosis with the danger of pyæmia. With the advent of sulphonamides and penicillin, we now have powerful agents which fill a big gap in our armamentarium against blood infections, and there is greater justification for a conservative attitude.

Spontaneous rupture of the lateral sinus is a relatively rare condition. Eulensteini (1903)<sup>9</sup> collected seventeen cases from the literature and others have been recorded by Friedenwald (1913)<sup>11</sup>, Smith (1933)<sup>19</sup>, Flynn (1933)<sup>10</sup> and Kemler and Tiefenthal (1942)<sup>14</sup>. I feel reasonably certain that the mastoid drain played little part in causing rupture of the sinus, as the drain used was a cigarette of rubber dam filled with gauze. Instead it seems probable that a necrosis of the outer coats of the sinus wall advanced by infection until the intima gradually protruded and ruptured from the pressure of the blood stream. Such cases have been observed by Smith (1933)<sup>19</sup>, who also records other cases where a thrombus in a small tributary of the sinus had been the starting point of the rupture.

One other point of interest was that, although the temperature reached 106·6°F. on one occasion, there was no delirium, and the patient conversed quite rationally. Anyone with tropical experience will confirm that such high temperatures are not unusual, but I must confess that this patient's temperature was rather alarming, and as it continued to rise from 105·8°F. by 0·2 of a degree every minute, I wondered when it was going to stop and when the iced sponging was going to have any effect. I have never felt such a rapid and bounding pulse as was present on this occasion.

## CASE III.—*B. Proteus Septicaemia with Left Temporo-Sphenoidal Brain Abscess.*

Pte. W.O. attended the Out-Patient Department with a history of discharge from the left ear for 18 months. He had experienced no pain in the ear but

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there had been increasing attacks of giddiness with left-sided temporal headache. On examination I found that he had a postero-inferior perforation of the left tympanic membrane with a fairly free muco-purulent discharge. There was no spontaneous nystagmus or Rombergism and a whispered voice was heard at 7 ft. He was admitted for further investigation. An X-ray of his mastoids showed increased opacity of the cells on the left side with loss of definition. In view of this finding and the fact that conservative treatment had not improved the condition of his ear, I decided to perform a modified radical mastoid operation. The mastoid was very sclerotic with few cells. The antrum was full of granulation tissue and there were small granulations on the dura of the middle fossa. A Kōerner plastic flap was cut and the cavity was skin-grafted. Two days after operation the patient again complained of severe left-sided headache and the temperature ranged between 100°F. and 101°F. with a pulse of 120. The posterior wound showed slight infection with *B. pyocyaneus* but otherwise its condition appeared satisfactory. There was no neck rigidity and no Kernig sign could be elicited but I started the patient on a course of sulphanilamide as a precautionary measure. On the sixth day after operation I removed the packing from the ear and the skin graft appeared to be taking well. The irregular temperature, headache and slight drowsiness continued, and I asked Major Ian Gordon, the Medical Specialist, to see him. He reported that the knee jerks and ankle jerks were absent but that the Babinski response was flexor. The chest was clear and the eye examination was negative. He thought the condition was due to toxæmia. The lumbar puncture showed the cerebrospinal fluid was under low pressure with 15 leucocytes per c.c. and the culture was sterile. Numerous red blood corpuscles were present as the procedure proved difficult in an unco-operative patient. Since the temperature had shown no response to sulphanilamide I changed to sulphapyridine, but without any improvement. By the tenth day, the patient no longer complained of headache but of pain in the small of the back, mostly over the sacro-iliac joints. Peculiar mental changes were also in evidence. The patient started to shout at night and allowed his whole body to go rigid without any sign of a fit or twitching. He was very uncommunicative but stated that he could stop the pain in the back by tying a pyjama cord round his left leg. The diagnosis appeared to be one of hysteria, but the irregular temperature in the evening of 100°F. to 104°F. was not explained. The urine examination was negative and the blood films showed no malarial parasites nor was there any leucocytosis. Polymorphs were 75 per cent., lymphocytes 28 per cent., monocytes 2 per cent. I asked Lt.-Col. Ascrott and his Neurosurgical team to see him but they also could find no localizing sign of an intracranial lesion. Their opinion at that time was that he was hysterical and they thought he should be allowed to get up. Sunlight and diathermy were suggested by the Orthopaedic Surgeon for the patient's backache which was considered to be a toxic fibrosis. I was, however, not satisfied with the progress of the patient. He looked ill and had lost a fair amount of weight. The irregular temperature had now been present for the three weeks since operation, and I had been unable to discover a cause. The ear itself was making excellent progress, the middle ear being practically dry with the mastoid antrum epithelializing well. It was more with the idea of

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excluding relapsing fever that I took a blood culture and I am afraid, when the first report showed the presence of *B. proteus*, I thought it was caused by laboratory contamination. Agglutination tests were, however, carried out, and the results are shown in the following table.

	SERA				
	Patient's Serum-Spec. 1	Patient's Serum-Spec. 2	Proteus O X 2	Proteus O X 19	Proteus O X K
Suspension of <i>B. proteus</i> isolated from blood	1/2500	1/2500	1/25	Nil	1/250
Suspension of <i>B. proteus</i> isolated from aural discharge	1/500	—	—	—	—

In view of the high titre obtained in the homologous test, it was considered the strain of *B. proteus* isolated from the blood was the causative organism. The urine examination was sterile. A further blood count showed 10,100 W.B.C.s. of which 82 per cent. were polymorphs. During all this period the sulphapyridine had been continued without any improvement in the irregular temperature, but by the end of the next week the patient seemed a good deal better both physically and mentally, though he had threatened to commit suicide on one occasion.

Exactly a month after operation, he had been up and about the ward in the morning and was reading the paper on his bed in the afternoon, when my ward sister noticed slight twitching of the right arm and right side of the face. This attack lasted for half-an-hour and was accompanied by some mental confusion. Four hours later he had a real Jacksonian fit which left him semi-comatose. He was seen by Lt.-Col. Ascroft in my absence and the diagnosis of a left temporo-sphenoidal brain abscess was made. The temperature at this time was 103°F. He was taken to the theatre and under a local anaesthetic Lt.-Col. Ascroft made a trephine opening 2 in. above the left ear and explored the left temporo-sphenoidal lobe. About 5 c.c. of foul-smelling pus was evacuated from a brain abscess in this area, and the cavity was injected with 1½ c.c. Thorotrast. The brain appeared soft and there was no real evidence of encapsulation. A small rubber drain was inserted into the abscess cavity. At the end of the operation the patient was given two pints of blood intravenously. The next morning there was a slight improvement in his condition but this was not maintained and he died 48 hours later. A Proteus Bacillus was cultured from the pus of the brain abscess.

### Post-Mortem Report

*Brain.*—"The anterior surface of the left petrous temporal bone has been chipped away and the exposed dura shows an epithelial covering on its external aspect. The dura opposite the trephine hole has been punctured. The whole of the left cerebral hemisphere is distinctly softer than the right and fluctuates on pressure. The left temporal lobe is firmly gummed down to the upper surface of the tentorium cerebelli and,

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on mobilizing the lobe a little, thick yellow pus oozes from the site of the adhesions. The anterior portion of the lobe is relatively unaffected. On section, an abscess is found to extend throughout the length of the temporal lobe, not very chronic and containing sanguino-purulent fluid. Antero-posteriorly it is 2 in. to 3 in. in length, 1 in. in depth and  $\frac{1}{2}$  in. in width. Towards the posterior end of the abscess it abuts closely on the left lateral ventricle and at one point has ruptured through the lateral wall. The ependymal lining of the left lateral ventricle is thickened and opaque; the right lateral ventricle is normal. The third ventricle contains a thin purulent fluid. The fourth ventricle contains inspissated pus. The posterior recess of the abscess extends down to the tentorium cerebelli which is adherent to the under surface of the temporal lobe at this point. The left half of the tentorium cerebelli is greatly thickened and its under surface covered with granulation tissue. The venous sinuses are normal.

## MICROSCOPIC REPORT

The appearance of the wall of the brain abscess indicates a sub-acute process. The infection of the ventricular system is much more recent."

### Comment

*Bacillus proteus* is not a common causal organism in intracranial complications of otitic origin. I have been able to find only 15 cases of this nature in the literature during the past thirty years, and it is rather significant that nine of these were recorded during the war period, viz.: Gertzog (1939)<sup>12</sup>, Neter and Chait (1940)<sup>17</sup>, Dearmin and Sims (1940)<sup>5</sup>, Cragg (1941)<sup>3</sup>, Adler and Klapper (1943)<sup>1</sup>, Lothrop (1943)<sup>16</sup>, and Sugar (1944)<sup>20</sup>. It may be, as Sugar suggests, that with the advent of chemotherapy we are becoming more bacteriologically minded and that more care is now taken in recording the organisms present in cases of brain abscess or sinus thrombosis. That the Proteus bacillus is a common secondary invader of the middle ear has been known for many years, but that it may take on pathogenic characteristics has not been fully recognized. Collins and Hughes (1941)<sup>4</sup> have suggested that it is one of the organisms which is responsible for the intractability to treatment of some cases of chronic suppurative otitis media, and Wirth (1935)<sup>23</sup> has carried out some interesting experimental work on the same subject.

In addition to this uncommon form of septicæmia and brain abscess, the case recorded shows some other points of interest.

A temporo-sphenoidal brain abscess was considered to be a possible complication during the first week of this patient's illness, but with the disappearance of his headache and the absence of localizing signs I was too easily satisfied. The queer mental changes which have been recorded, such as the tying of the cord round his leg, yelling in a loud voice and

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writhing about in bed, together with his general air of martyrdom seemed to point to a schizophrenic personality, and when I had obtained a positive blood culture for *B. proteus* I felt the problem of his illness had been solved. On reviewing his case in the light of later events I feel that these symptoms were of more significance than was realized at the time, especially when taken in conjunction with the fact that the patient looked ill. One might well have expected, however, some dysphasia or other localizing sign in a left temporo-sphenoidal brain abscess of this size in a right-handed subject. The sulphonamides appear to be of no benefit in treating *B. proteus* infections which are of otitic origin though they are said to be effective in treating urinary conditions caused by this organism. The question as to whether it would have been better to explore the temporo-sphenoidal lobe through the mastoid cavity or by a trephine opening was debated. After attending the post-mortem I feel that better drainage would have been obtained through the mastoid cavity, but in view of the rupture of the abscess into the lateral ventricle, *it is probable that the end result would not have been affected.*

In conclusion I should like to thank Major Alan Morgan for his excellent post-mortem reports of which condensed versions only have been given. I should like also to include Lt.-Col. P. Ascroft, Major M. Kremer, Major Ian Gordon and Major Cockburn for their great help and co-operation in treatment. My thanks are also due to Col. H. J. A. Longmore, late R.A.M.C., formerly Officer Commanding 15th (Scottish) General Hospital, for his permission to publish these reports.

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## LOW-VOLTAGE GALVANIZATION IN SINUSITIS

By E. KUPFER (London)

THIS article continues our first report on the subject, which appeared in 1934 in a paper on the ear<sup>18b</sup>. Since then the treatment has been effective in hundreds of sinus cases, with quick and satisfactory results.

Research *in vitro* and *in vivo* has revealed that electrical currents may act in two different ways: *locally* by virtue of vascular changes<sup>10, 11, 20</sup> and lethal effects on micro-organisms and bacteria<sup>25, 30</sup>—and *systemically* by a stimulating action on vital autonomic centres<sup>11, 26, 29</sup>. Erb<sup>11</sup> and Seyderhelm<sup>25, 26</sup> have shown that both kinds of action may be obtained in direct as well as in surface-stimulation.

The local and systemic possibilities of low-voltage galvanism in the treatment of infection have been neglected in the course of modern progress and discoveries, though it is well-known that in the treatment of Sinusitis operations<sup>2, 14, 24, 28</sup> and short waves<sup>3, 14, 22, 28</sup> may be harmful; that heat<sup>4</sup> and ephedrine<sup>7, 9</sup> often give only transitory relief, and that even sulphonamides<sup>4, 5, 8, 28</sup> and penicillin<sup>8, 4</sup> are frequently without effect. Yet a quick and effective galvanic treatment of the accessory sinuses has been developed in the clinic of Professor Voss at the University of Frankfurt<sup>18b, 19</sup>, but unfortunately it is hardly known in this country. The object of this paper is to give a brief description of our method.

The sign of the electrodes and the quantity and density of electricity are important factors—the source of the current seems of minor significance. Generally speaking we found the variations of the constant current from a low-voltage grid-bias battery more effective than any treatment by transformers from the main. Consequently, the apparatus required is of the simplest description and can be procured at very little expense. The technique is easy to acquire. Both are described below.

### Apparatus and Technique

The following items are required :—

(1) A grid bias battery of 16.5v. in steps of 1.5v. If the well-known "Ever-Ready" or other radio batteries of this size are not available—2 x 9v. batteries may be connected by copperwire ending in plugs. The batteries ought to be replaced every four to five weeks as their inner resistance tends to increase ;

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(2) a Milli-Ampèremeter;

(3) a Potentiometer;

(4) three Electrodes : two square-shaped active electrodes ( $5 \times 5$  cm.) and a rectangular indifferent electrode ( $5 \times 10$  cm.), made of the flexible alloy Britannia\*. The rectangular electrode should be applied to the nape of the neck, approximately at the level of the medulla ; and the active square electrodes to the temples—point upwards, equidistant between the ear and the outer angle of the eye†. It is important that

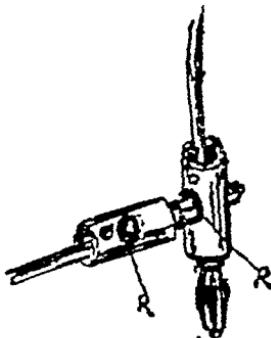


FIG. 1.

Two plugs connected by insertion of the contact-pin of one into the ring-shaped socket (R) of the other. The metal-lining of the contact-rings (R) ought to be continuous and uninterrupted for the sake of perfect contact.

the temple-electrodes should be of *negative* and the neck-electrode of *positive* sign. All three electrodes should be applied with their covers wet and very hot. They are covered by "Amadou" or if this is not available by three layers of surgical cellulose (Celluline). Scrape the electrode metal whenever dim—as well as the bare metal contacts of the wires. The conducting fluid at the electrodes should be plain, hot tap-water only without any chemicals or Na Cl.‡.

Our *technique* has been guided by two principles :

(1) that the effect of a current is proportional to its quantity and density ;

(2) that the electric action on centres, micro-organisms and tissues depends not only on the quantity and density of the current but also on its variation and impact. Therefore current-impulses, current-alterations and fluctuations should alternate with the action of a completely constant potential.

In order to secure the necessary quantities of electricity as well as the intended variations of the current, some of our sittings consisted of

\* Britannia metal : an alloy of 85·64 tin, 9·66 antimony, 0·81 copper, 3·06 zinc, 0·38 bismuth.

† The density and the path of the current at constant intensity and conductivity are determined by the area and the position of the electrodes. (Brenner<sup>2</sup>, Erb<sup>11</sup>, Krueger<sup>7</sup>.)

‡ For reasons stated by Erb<sup>11</sup>, Friedenthal<sup>13</sup>, Beutner<sup>2</sup>, Zinsser and Bayne-Jones<sup>30</sup>.

two stages or more—changing over from the constant current of a battery to the direct current of a pantostat, or to further treatments by battery.

In the following, our treatment by battery only will be described. The necessary variations of current and technique may be obtained by means of various connections between the battery and the patient—and the increase and decrease of the current according to two different methods :

(1) by means of *current-impulses* in steps of 1.5v.—alternating with momentary short-circuit currents : our so-called “Impulse-technique”;

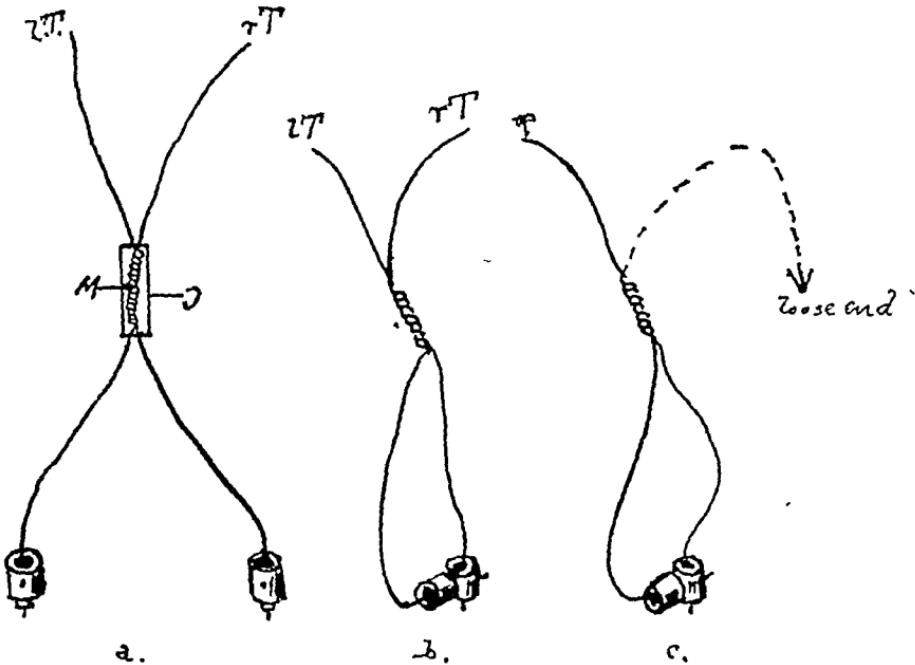


FIG. 2 A, B, C.—THE LEADS OF THE DIFFERENTIAL NEGATIVE ELECTRODES.

- (2A) Untwist the two pieces of copper lamp flex of 110 cm. length, strip the insulation in the middle of each for a distance of 5 to 7 cm. and scrape the metal. Twist the two bared middle portions (M) together and re-cover them by insulating tape (I). The two lower branches of the combined leads ought to end in wanderplugs and the bare tips of the upper ones in the temple-electrodes (T) of the patient.
- (2B) Leads in position A and c of Fig. 3.
- (2c) Same—in the unipolar treatment of the cases 7 and 8 with one of the upper branches disconnected (broken line).

(2) by means of a gradual infiltration and defiltration of the potential—the “Infiltration technique”\*.

For the “*impulse-technique*” either the simple connection A (Fig. 3) or the more complicated connection B (Fig. 4) may be considered. Both will be described below.

*Connection A* for “*impulse-technique*” joins patient and battery in parallel (Fig. 3). It is by far the simplest arrangement and requires

\*Method 2 has been found to intensify the effects 1 to a considerable degree.

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only a special preparation of the leads for the necessary variations and fluctuations of the current :

*For the indifferent positive neck-electrode* a single core-cord of insulated copper-twinflex will do. *For the active negative temple-electrodes* the two leads of lampflex should be connected and provided with wanderplugs according to Fig. 1 and 2.

The procedure is as follows :—

Fix the bananaplug at the end of the positive neck-electrode *permanently* to the extreme + terminal of the battery and proceed with the two wanderplugs at the lower branches of the active negative leads according to Fig. 3a, b, c.

In Fig. 3a both the wanderplugs X and Y are plugged into the socket 1.5v. of the battery by means of the pin of plug X.

In the next step plug Y is removed from the contact-ring of plug X and inserted into the battery-socket 3v.—thereby causing fluctuations in the circuit and a momentary short-circuit current between the sockets 1.5v. and 3v.—see Fig. 3b, which shows plug X on 1.5v. and plug Y on 3v. Now plug X is removed quickly from the socket 1.5 and plugged into the contact ring of plug Y—as seen in Fig. 3c, which shows both the wanderplugs X and Y linked once more—this time on the socket 3v. of the battery.

Repeat the procedure in steps of 1.5v. from socket 3 to 4.5v. to 6, to 7.5v. and so on, until a voltage of 9v., 10.5v. or more has been reached.

As soon as the patient reports that the breathing becomes free and easy, and that the head-congestion subsides, no further increase of the current is required. At this optimum a constant voltage ought to be applied for 10 to 15' (minutes), before the current is gradually lowered again to 0. The lowering of the potential is done by the same process of separating and linking alternately as before, the two lower branches of the (—) electrodes.

The first two treatments should be on successive days, while the subsequent ones may take place after intervals of 48 to 72 hours. With new batteries and fresh electrode-covers the above technique will suffice to relieve pain and congestion and to clear the discharge of pus and blood—if applied along the lines of the Cases I, II or III—(see below).

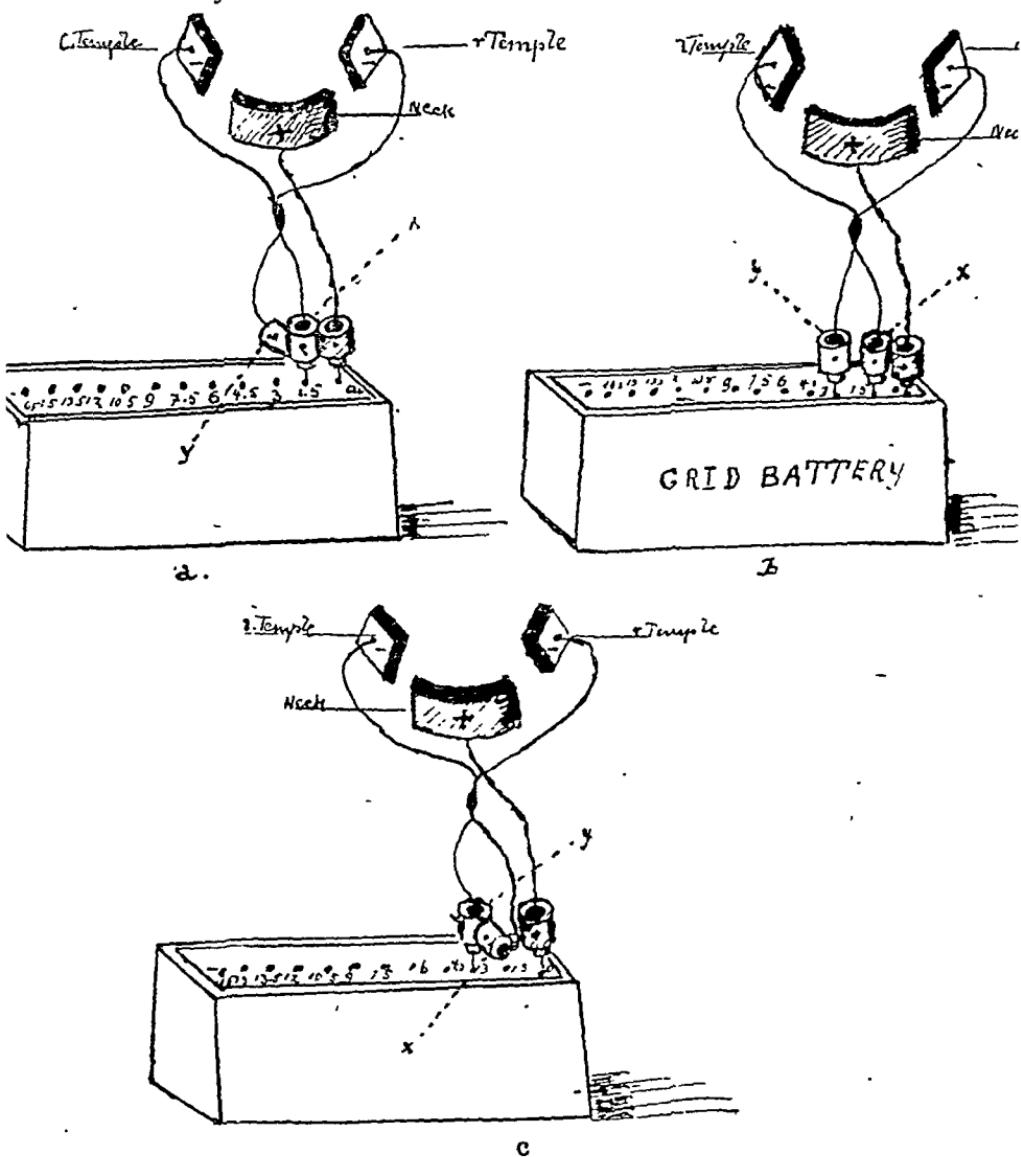
Usually the optimal voltage is between 9 and 13v.; frequently 9 to 10.5v. is sufficient in acute infections, which may clear up after two to three sittings. In chronic or refractory cases, however, it may be advisable to increase the voltage slightly and to stop the treatment not abruptly but gradually: with decreasing intensities of the current and increasing intervals between sittings, in order to insure against relapse.

Some further details will be given in the case reports below in illustration of A, the easiest way to procedure, which, however, allows merely the determination of voltage and time.

Later in our treatment we preferred to combine it with the more complicated connections B and C, which by insertion of an MA-meter enable one to read the current intensity and to determine the *quantity of electricity applied*.

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According to Grossman and Appleton<sup>15</sup> the antibacterial effect of a current is proportional to this quantity of electricity. They show how both vary with the electrical decomposition of the medium in conformity with Faraday's Law :



Anode : shaded. Kathode : white.

FIG. 3 A, B, C.—Connection A.—Impulse Technique in direct parallel connection of battery and patient.

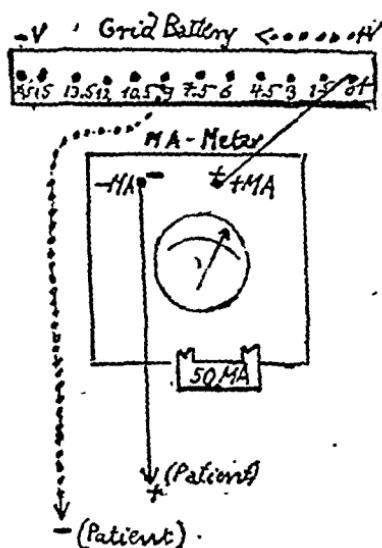
"That for a constant quantity of electricity the amount of electro-chemical action is also a constant quantity—whatever the decomposing conductor might be—whether water, saline solution, fused bodies, etc."

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The quantity of electricity amounts to the product of Milliamperes  $\times$  minutes of application—in short MA-minutes (MA'). It may be determined by the insertion of an MA meter, as shown in Connection B.

For Connection B (Fig. 4) the serial connection of battery, MA meter and patient for "impulse-technique" proceed as follows:—

Join the extreme + terminal of the battery to the + terminal of the MA meter and the (—) terminal of the MA meter to the lead of the positive neck-electrode. (See Fig. 4: Continuous line of the anode.)



Dotted line: Kathode. Continuous line: Anode. Current increase in direction of the dotted arrow.

FIG. 4—CONNECTION B.—Impulse-Technique in serial connection of battery, MA = meter and patient.

The negative leads (Fig. 4 dotted line) connect directly as before the wander-plugs on the battery to the active temple-electrodes of the patient.

The increase and decrease of the voltage and intensity by current-impulses of 1.5v. is arranged as above on the battery by means of the wanderplugs at the lower branches of the multiple negative pole.

The optimal intensities are usually between 8 and 12 MA. The effect of both techniques A and B may be intensified by further treatment at the same sitting, either by a motor-generator pantostat or by a battery in the "Infiltration-technique" of connection C, which permits of gradual penetration and defiltration of the potential by means of a potentiometer.

Connection C (Fig. 5) of the battery, potentiometer, MA meter and patient for "infiltration-technique", is as follows:—

The positive lead connects the extreme + socket of the battery to the + terminal of the potentiometer; the medium (M) of the potentiometer to the

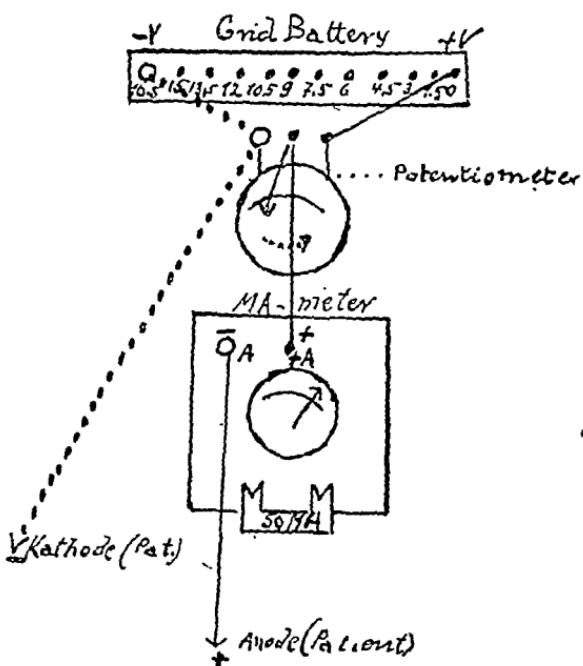
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+ terminal of the MA meter; and the (-) terminal of the MA meter to the positive neck-electrode of the patient. (See Fig. 5: Continuous line of the Anode.)

The negative leads connect the extreme (-) socket of the battery *via* the (-) terminal of the potentiometer to the negative active temple-electrodes of the patient. (Fig. 5: dotted line of the Kathode.)

In short: Connect potentiometer and battery in parallel and the rest in series.

The gradual increase and decrease of the current is controlled by moving the knob of the potentiometer in direction and counterdirection respectively of the dotted arrow. In most cases the optimal intensity seems to be reached



Dotted line: Kathode. Continuous line: Anode. Current increase in direction of the dotted arrow.

FIG. 5—CONNECTION C.—Infiltration-Technique in connection of battery, potentiometer, MA-meter and patient.

at about 10 MA and should be applied for 10 to 15 minutes, before the current is gradually lowered to 0 in steps of 1 MA per minute. If the skin is too tender, 6 to 8 MA may be effective as well.

It has been shown by Crile<sup>6</sup> in photomicrographs that electrolyzed micro-organisms have a tendency to recover when the current is stopped and to recombine when the poles are reversed. This seems to be corroborated by our experience that always a minimum of two to three sittings were necessary, and that our treatment was ineffectual when during its course the poles were reversed in error.

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If slight burns should occur, they will heal easily, if *pasta zinci Ph.G.* is applied freely after the sitting and in the intervals between appointments.

We advised patients to keep warm, to cut down their salt and fluid intake, to avoid smoking, draughts and sharp winds—and to keep their bedroom-windows temporarily closed at night\*. Otherwise they should have as much sun and air in day-time as possible.

Paper-handkerchiefs or adequate squares of surgical cellulose should be used for the discharge in order to avoid spreading and re-infection. For similar reasons<sup>23</sup> and also because of their often irritating properties—no nosedrops were applied during the course of the treatment. The blood-pressure was measured and recorded—especially in elderly or nephritic cases.

As general infection, influenza<sup>24</sup>, anaemia,<sup>14, 24</sup> endocrine deficiencies<sup>24</sup>, poor circulation and in some cases sore throats, bronchitis<sup>14</sup> and conjunctivitis<sup>14</sup> frequently play a part in keeping the infection active—some mild antipyretic drugs<sup>14, 18b</sup> and counter measures against the above conditions may support the electrical treatment, if necessary. Some of these supplementary measures and the rest of the technique may be learnt from the case-reports, which have been selected for the purpose of showing several modifications of the treatment in acute and chronic cases.

## Case Reports

The letters A B C stand for the connections of Fig. 3, 4, 5 respectively ; the abbreviations "uni." and "bi." for unilateral and bilateral ; ' for minutes of application. Without special indications the treatment is understood to be bilateral and the increase and decrease of the current to be in steps of 1.5v. or 1 MA per minute. At every sitting the nose ought to be blown carefully before the start of the treatment and once more during its first phase of constant potential, to which the short notes as to voltage, time and intensity apply.

CASE I.—E.K., female, 45. Septum-operation 12 years ago. Violent, sudden attack of suppuration and frontal headaches. Discharge mixed with blood. Treated by A (Fig. 3) on two days in succession : 1st day : 9v. 10' ; 10.5v. 1'. 2nd day : { 10.5v. 3-4'. 9 : 10'.

The attack was checked completely, though on former occasions the patient, when attacked, had suffered severely for months.

An instance of supplementary treatment by pantostat before and after an operation may be seen in Case 2.

CASE II.—E.Sch., male, 39. Chronic case of 18 months' standing with severe frontal headaches, suppuration and poor airway. An intended septum-operation seemed out of the question because of the persistent inflammation. Again A (Fig. 3) : up to 14v. ; 10.5v. 10' led to immediate relief under

\* Also they should try to reduce the recumbent position at night by propping themselves up in bed as much as possible.

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current. A supplementary treatment on the same sitting by the slightly oscillating current of a *Motor-Generator Pantostat*: up to 14 MA; 10 MA 10'—relieved headache and congestion.

After another treatment by pantostat on the next day, the septum operation was possible two days later. Some subsequent galvanizations led to progressive improvement and finally to a cure three weeks after the first sitting.

CASE III.—Prof. S., male, 50; subacute; new attack.

1st sitting: A: 10·5v. 3-4'; 9v. 10'.

2nd sitting (next day): A: 9v. 10'; 10·5v. 1'. After considerable improvement the next treatment took place two days later.

3rd sitting: As above. After another two days' interval:

4th sitting (with decreasing voltage and time of application): A: 9v. 5'; 10·5v. 1'. (All symptoms gone).

Here the treatment was stepped down gradually with decreasing voltage and greater intervals between appointments. It had been supplemented by small, gradually decreasing doses of Treutaps and Pyramidon. The same applies to the cases 4 to 7, which demonstrate alternative treatment in the connections A, B and C.

CASE IV.—K.H., female, 41. Acute attack with severe frontal headaches, discharge of pus and blood, tenderness in forehead and antra.

1st sitting: A: 10·5v. 3-4'; 9v. 10'; considerable improvement.

2nd sitting (next day): B: (Fig. 4) 10·5v., 8 MA 10'.

3rd sitting (next day but one) in three sections:

(1) B (Fig. 4): 10 MA 10'.

(2) A (Fig. 3): up to 15v. and back to 0.

(3) C (Fig. 5): 9-10 MA 10' (cured).

In the next case, it was effective to apply all three connections on the first sitting.

CASE V.—R.O., male, subacute; previous early septum-operation; occasional recurrence of sinusitis during attacks of influenza.

1st treatment: exactly as in sitting 3 of Case IV. (Patient immediately free of symptoms). But in order to prevent relapse:—

2nd treatment (two days later in two sections):

(1) B: 9v. 10MA 10'.

(2) C: 10MA 10' (cured).

The next instances demonstrate our procedure in preponderant or recurrent affliction on one side.

CASE VI.—E.S., female, 56. Severe attack of influenza. Sinusitis without much purulent discharge; high temperature, excruciating headache left.

1st sitting (in two sections):

(1) A: up to 10·5v.; 9v. 10'.

(2) B: 6-8MA 10'; 9MA 1' (considerably improved).

2nd sitting (next day): C: 6-8MA 10' (patient well for a week. Then a relapse of the headache left recurred in consequence of a continuous draught).

3rd sitting (after eight days' interval) with one active (—) electrode connected by a single lead to the aching temple only: C: (uni.) 10MA 10' (cured).

## Low-voltage Galvanization in Sinusitis

In the following cases of predominant one-sided symptoms a variation from this procedure proved effective.

CASE VII.—R.W., male, 23; poor airway, suppuration, discharge mixed with blood, severe headaches predominantly l.

1<sup>st</sup> sitting : A (bi.) : increase to 14v.; 13v. 12'; 10·5v. 10' (some improvement).

2<sup>nd</sup> sitting (next day) in three sections. During the first unilateral part the wanderplugs of the lower branches of the multiple (—) pole proceeded on the battery as usual, but only *one* cable of the upper branches was connected to the temple-electrode of the aching side—the other end was hanging loose (see Fig. 2c).

(1) B (uni.) : 10MA 15'; after lowering the current in steps to 6MA, the hanging cable was connected to a second active (—) electrode on the other side and the current re-increased in steps to 10MA.

(2) B (bi.) : 10MA 10'.

(3) C (bi.) : 10MA 10' (cured).

A similar technique was applied gradually in the next instance, which at the same time shows some further adaptations of the method in a complicated chronic case.

CASE VIII.—E.J., female, 63; chronic. Longstanding constant pains below angle of l. jaw, below l. ear and in the l. cheek. History of sore throats, conjunctivitis, vertigo, three years' pain and partial deafness in l. ear. Enlargement and tenderness of l. maxillary gland. Tenderness of and above both frontal and maxillary sinuses. Nose congested and poor airway. Discharge very thick and mixed with blood. Pain over both eyes and in between. Puffiness in face and forehead. The X-ray showed both antra opaque and infected. Frequent applications of ephedrine and sulphonamides had been without effect. The galvanization started with the usual instructions as to diet and conduct—discontinuing ephedrine and sulphonamide treatment.

1<sup>st</sup> sitting (with (—) electrodes lower than usual) : B : 9v. 6MA 10' (breathing and headaches improved for 24 hours).

2<sup>nd</sup> sitting (next day) in two stages—with (—) electrodes as usual :

(1) B : 9-10v. 7-9MA 15'.

(2) C : 8-10MA 10'. Sinus symptoms further improved, but some slight headache l. returned after 24 hours.

3<sup>rd</sup> sitting (next day) in three stages with (—) electrodes high on forehead near site of headache :

(1) B (uni.) : 14v. 9-10MA 15'; decrease to 6MA and branching of (—) pole to both sides, etc., as above in Case VII;

(2) B (bi.) : 9-10MA 10'.

(3) C (bi.) : 6-10MA 10': no more sinus symptoms for 24 hours.

4<sup>th</sup> sitting (next day). From now on (—) electrodes as usual.

(1) B (uni.) : up to 10MA, 6-7MA 12'; decrease to 6MA and branching and re-increase as above :

(2) B (bi.) : 6-8MA 15'. (During a four days' interval free of sinus symptoms—except for some slight discharge in the mornings.)

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5th sitting (four days later).

- (1) C (uni.) : 8MA 10'; decrease to 3 MA and branching as above, etc.
- (2) C (bi.) : 8-9MA 10'. (Reaction as above.)

6th sitting (next day).

- (1) B (bi.) : 7.5v. 8.5MA 10'.

- (2) A (bi.) : 6v. 10'.

- (3) C (bi.) : 7-8.5MA 15'. (Free of all sinus-symptoms for 24 hours.)

7th sitting (next day).

- (1) C (bi.) : 5-6MA 15'.

- (2) B (bi.) : 6MA 15'.

Patient from now on free of sinus symptoms: breathing permanently easy; all discharge, pains and headaches gone. After another four days' interval, the galvanic treatment of the ear started along the lines described in 1934<sup>18b</sup> with good results. In the second week the treatment was supported by small doses of veganin or anadin and some eye-drops.

In none of the cases quoted had a growth or calculus been revealed by radiography, though in Case VIII it had been suspected at first.

## Discussion

In a great majority of cases the quantities and densities of current described above have proved sufficient\* to free patients of symptoms in a surprisingly short time. But in taking the time factor into consideration, we succeeded in applying considerable quantities of electricity—in spite of very low voltage.

Our early tentative attempts at an explanation<sup>18b</sup> mentioned effects of synæresis and electrophoresis beside the power of electrical currents to draw the bactericidal bloodstream towards points of application.

Meanwhile, R. Keller<sup>16</sup> and G. Crile<sup>6</sup> have shown that nucleus and cytoplasm of cells and micro-organisms carry electrical charges of opposite sign. In general bacterial protoplasm is negatively charged on the surface, has a tendency to migrate if possible to the anode, and consists essentially of micellar suspensions in fluid—as pointed out by Zinsser and Bayne-Jones<sup>30</sup>. These showed further that bacteria and micro-organisms in suspension offer a greater electrical resistance than the surrounding medium, and that consequently bactericidal electrophoretic and electrolytic effects are likely to occur in the passage of electrical currents.

But simultaneously with the quick and striking clearing and drying up of the discharge, there are obvious effects on the circulation and the general condition of the patients immediately after the treatment. It is therefore difficult to decide at present, whether the action is local or systemic or both. That it is probably due to both local and systemic effects seems supported by earlier and contemporary findings:

\* When once by way of trial one of us in an acute attack had had as much as 1108MA-minutes in only three sittings, the attack was cut short immediately but tiredness supervened instead of the usual bracing after-effect.

# Low-voltage Galvanization in Sinusitis

Erb<sup>11</sup> and Meissner<sup>10</sup> observed local, *vascular* effects of galvanism according to polarity\*; Crile<sup>6</sup>, Uhlenbuth and Seyderhelm<sup>25</sup> have shown microscopically the lethal action on micro-organisms and bacteria after local application of galvanic currents†; while Erb<sup>11</sup>, Veraguth and Seyderhelm<sup>26</sup>, Kupfer and Voss<sup>19</sup> report effects on blood, vasomotors and other autonomic functions in galvanic surface-stimulation on vital centres.‡

As in our method the application-points of the positive neck-electrode are on vital autonomic centres, and those of the negative temple-electrodes near local sites of the affliction—both local and systemic effects seem to co-operate. However, the exact mechanism of the action can only be determined by further clinical and laboratory observation.

The technique described is very simple. But knowing from experience that any technique seems more complicated in print than in practice, I offer to demonstrate the treatment and its action to any institute or specialist, who might be interested.

## Summary

The apparatus, technique and action of a quick and easy galvanic treatment of the accessory sinuses is described and supplemented by case-reports. Some suggestions as to the mechanism of its action have been submitted, followed by an offer of the author to demonstrate the treatment if required.

\* Vasoconstriction near the Kathode and vasodilation under the Anode<sup>11</sup>.

† The former by photomicrographs *in vitro*<sup>6</sup>—the latter two<sup>25</sup> *in vitro* and *in vivo* after surface-application on a mammalian limb.

‡ All of them by low-voltage galvanization.

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## CLINICAL RECORDS

### UNILATERAL POLYPOUS HYPERSTROPHY OF TONSIL

By BRIAN REEVES (Major, R.A.M.C.)

THE following case would appear of interest as I can find no reference to a similar case in recent literature. I have seen unilateral hypertrophy of the tonsil resulting from chronic inflammation or associated with malignancy, but have not observed, unilateral idiopathic polypous hypertrophy.

Starry<sup>1</sup> reports the examination of 8,516 pairs of tonsils. "Every tonsil received in the laboratory was fixed in formaldehyde then sectioned longitudinally at right angles to the mucous surfaces, dehydrated in acetone and

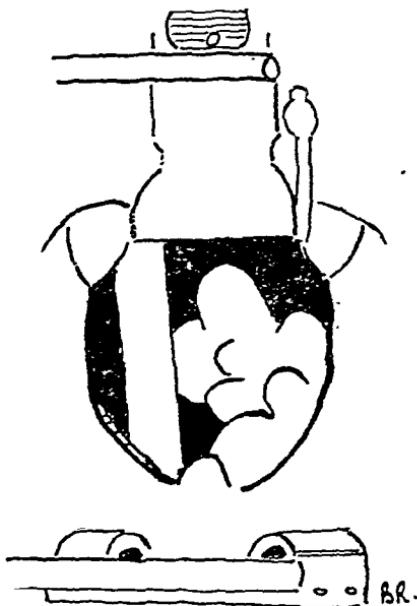


FIG. 1.  
Tonsil *in situ* at time of operation.

embedded in paraffin. Sections were made and stained with haematoxylin and eosin." "In this group seven cases of tonsillar tuberculosis, five cases of syphilis of the tonsil, four cases of tumour (two malignant and two benign), and one case of trichinosis were found." "The remaining cases all showed in varying degree evidence of acute or chronic inflammatory change." "... of the four tumour cases, two were malignant and two benign. One was a lymphosarcoma in a boy of 16 years of age, the other a squamous cell carcinoma in an adult. The benign tumours were both papillomas in adults."

# Brian Reeves

Evans and Odom<sup>2</sup> report a case of polyp of the tonsil. This was a single pedunculated tumour attached to the upper pole.

New and Childney<sup>3</sup> report 63 cases of benign tumours of the tonsil and pharynx, 10 were papillomata of tonsil and were single growths and were apparently attached by a short thin pedicle. Microscopically they consisted of a fibro-vascular core covered with fimbriae of stratified epithelium.

There was one case of a lipoma situated in the tonsillar fossa. There were five lymphoid tissue tumours, but not one of these corresponds either clinically or microscopically to the case about to be reported.

Hanckel<sup>4</sup> reported a case of bilateral polyp of the faucial tonsil.

Pearlman and Pilot<sup>5</sup> report four cases of lymphoid tumours. Case I. Multiple lymphoid tumours. In this case the tumours were pedunculated and on section were the same consistency as the tonsillar tissue which consisted largely of hyperplastic lymphoid tissue without marked increase in the interstitial connective tissue. The other three cases were single polyps of the tonsil, microscopically composed of hyperplastic lymphoid tissue. Case I. resembles histologically most closely the case to be described.

## Case Report

C., Italian Prisoner of War, age 42, married, was sent to me on November 28th, 1944. He could not speak English.

He was complaining of a painless lump in his throat which he said he first noticed eight months previously.

He had had no previous trouble with his throat, no difficulty in swallowing, no loss of weight and no haemoptysis. He had a slight cough.

There was no history of Venereal Disease.

Physical examination showed a well nourished man.

He was afebrile.

There were no palpable glands in neck.

Pharynx : The right tonsil was replaced by a large multiple lobulated polypoid mobile mass extending across the pharynx and touching the left tonsil, which appeared normal.

The tumour was firm and each lobule presented a glistening unbroken surface.

He had a good nasal airway. The post-nasal space was clear.

His spleen was not palpable.

Blood Kahn was negative. There were no tubercle bacilli seen in his sputum.

Radiological examination of chest revealed nothing abnormal.

Blood sedimentation rate (Wintrobe) 2 mm. fall in one hour.

Blood Count : Haemoglobin 13.0 mg. per cent.

83.4 per cent. of average normal.

White Blood cells : 9800 per c.mm.

Polymorphonuclear : Neutrophils : 65.5 per cent.

Eosinophils : 2.0 "

Basophils : 1.0 "

Lymphocytes : 26.5 "

Monocytes : 5.6 "

UNILATERAL POLYPOUS HYPERSTROPHY OF TONSIL—  
BRIAN REEVES.



[Photo by Major J. Charnley, R.A.M.C.]

FIG. 2.  
Postero-Lateral Aspect of Specimen.



FIG. 3.  
Photo-micrograph  $\times 13$ . (See Text.)

## Clinical Records

The diagnosis of sarcoma was made and it was decided to remove the right tonsil for section.

This was done on *December 4th, 1944*, under general anaesthesia with intra-tracheal (N<sub>2</sub>O., 0·2 Ether). I sketched the tonsil in situ while the patient was under the anaesthetic.

It will be seen that it is only separated from the other tonsil by the pharyngeal portion of the intra-tracheal tube.

The tumour was removed quite easily with very little bleeding.

The specimen measured 4·75 × 3·5 cm.

It was placed in 5 per cent. formaldehyde saline, photographed two days later and sent to the Pathologist who reported :—" The specimen is a tonsil with a mass projecting from its mucosal surface. The under surface is covered with ragged tags of grey and brown loosely packed connective tissue and muscle, indicating complete removal with under surface covered by normal tissue. There is a narrow rim of pharyngeal mucosa around the mid-zone or waist of the specimen and the distance between the surface of the mucosa and the under surface of the specimen is up to about 1·2 cm., i.e. that is the depth of the tonsil. But projecting above the level of the surface of the pharyngeal mucosa to a height of 2 cm. there is a firm lobulated polypous mass (4 × 2 cm.) with a smooth white surface, the lobules being separated by deep clefts (up to 0·8 cm. deep). The mass overhangs its base of origin from the tonsil ; the area of this base is 2·3 × 1·7 cm.

In two slices selected from different parts the microscopical sections show everywhere the normal architecture of tonsillar tissue. There are lymphoid follicles composed of large germ centres of the simple hyperplastic type surrounded by zones of lymphocytes. Between the follicles the strands of medulla are composed of lymphocytes, reticulum cells and vessels. Dense fibrosis has replaced a few areas. There are numerous crypts lined with squamous epithelium ; between and deep to the epithelial cells there is slight inflammatory infiltration with neutrophil leucocytes. Some of the crypts are distended with the usual tonsillar crypt debris of desquamated disintegrated keratinized epithelium. Two of the crypts contain a few colonies of the common tonsillar fungus, but around them there is no more inflammatory infiltration than elsewhere. Thus there is no indication of malignancy and the condition can be aptly described as polypous hypertrophy or hyperplasia, of the tonsil."

Dr. W. W. Woods (The Bernhard Baron Institute of Pathology, The London Hospital) in a personal communication states that " it is the most remarkable specimen and I cannot remember having seen another like it ".

The patient had a normal convalescence, with rapid healing of the tonsil bed.

He was last seen *March 7th, 1945*, that is three months after removal of the tumour. He is well and symptomless. There was no sign of recurrence.

### Commentary

The case is remarkable in that the patient only noticed this large swelling in his throat for eight months.

He had very little in the way of symptoms.

Clinically the diagnosis was one of malignancy. Microscopically there was no evidence of malignant change.

## Brian Reeves

I am greatly indebted to Major R. Townsend, R.A.M.C., and Dr. W. W. Woods who reported on the pathology and I wish to thank Colonel M. J. Williamson, M.C., for permission to submit these notes for publication.

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## A CASE OF LATERAL SINUS THROMBOSIS, DUE TO BACILLUS PROTEUS, WITH RECOVERY

By J. F. BIRRELL (T/Major, R.A.M.C.)

THROMBOSIS of the lateral sinus due to *B. proteus* is still sufficiently uncommon to justify a further case report. A review of the literature would seem to suggest that this type of infection was increasing in frequency, but, as Sugar (1944) points out, this may be due rather to routine examination of pus at operation than to any increased virulence of the organism. One can find reports of thirteen cases of lateral sinus thrombosis in the literature, and, of these, six have survived. This small number is perhaps surprising when one considers that bacteriologists regard the middle ear as a common habitat for the organism. One might have expected an increase in wartime, as *B. proteus* occurs commonly in war wounds (Mitchell, 1944) and therefore may occur in traumatic otitis media. In *Medicine of the Ear*, edited by E. P. Fowler, Jnr., it is stated that "culture from chronic otitis media rarely gives a single organism. Occasionally one finds *S. albus*, diphtheroids and *B. proteus*, and often these hide the true haemolytic streptococcus or haemolytic staphylococcus infection which produces underlying bone infection responsible for the chronicity of the discharge". Yet the cases described in the literature all speak of a pure culture of *B. proteus*, and, in my own case, the Pathologist was most emphatic that no other organism was present.

Of the seven cases that terminated fatally three (Kerman, 1922, McGovern, 1936, and Pavey-Smith and Miller, 1935) died from septicæmia while four (Pagniez, Plichet and Decourt, 1932; McGovern, 1936; Vallée and Giroux, 1937, and Adler and Klapper, 1943) succumbed to pulmonary complications. Pneumonia and lung abscess appear to be a grave danger in these cases, and Cragg's (1941) case had a empyema and lung abscess before recovering.

Success in those cases who recovered has been variously ascribed to bacteriophage (Gerzog, 1939), careful surgery and open drainage (Dearmin and Sims, 1940) and chemotherapy (Cragg, 1941 and McKee, 1944). McKee favours sulphapyridine in preference to sulphanilamide. Lothrop (1943) also used sulphapyridine in his case.

Blood culture was positive in four of the successful cases, and negative in one (Stein, 1930). In Dearmin and Sims' paper there is no mention of blood culture, but *Proteus vulgaris* was found in the clot of the lateral sinus, and in the temporal lobe abscess which co-existed.

In four of the successful cases the mastoid had been opened previously, and in one the sinus had been tied at the first operation (McKee 1944). This unusual preponderance of re-infected mastoids may mean that *B. proteus* had been present since the first operation, as none of the cases had dried up after the initial mastoidectomy.

# J. F. Birrell

## Report of a Case

A gunner, aged 37, was admitted to this hospital on January 26th, 1945. He had seen another Otologist in November, 1944 on account of two week's history of right aural discharge. He denied ever having had previous trouble in either ear. The notes of this first examination stated that in the right ear there was a "high anterior polypus" which "fell off during examination" leaving a "small high central perforation". This was powdered, and, on being re-examined in three days, was dry.

The ear remained dry until admission, and gave him no trouble until four days before he was admitted when he felt ill and had pain in front of the right ear. He did not report to his Medical Officer, and the pain eased though he continued to feel unwell. On the day of admission he had intense frontal headache, so he reported to his Medical Officer who found he had a fever and sent him to hospital.

On admission he appeared extremely ill. He was grey and sweating. He had severe frontal headache which was increased by a cough. His temperature on admission was 102.2° F., pulse rate 96 and respiratory rate 24. Shortly after admission he had a rigor, his temperature rising to 104° F. and falling to 98.8° F. while his pulse rate dropped steadily to 80 and 64. He had no aural pain or discharge, but was deaf in the right ear. Membrana tensa was intact and faintly pink marginally but not bulging. The posterior part of membrana flaccida was normal, but the anterior half was obscured by what looked like a small septic blood clot, yellowish-green in colour and apparently arising from the attic. The meatus was perfectly dry. There was no mastoid tenderness or oedema, and no periosteal thickening was felt over the mastoid process.

The left drum was normal. His nose was congested but contained no pus. He was tender over both frontal sinuses. His tongue was dry and furred, and his throat was congested.

There was no neck rigidity. Kernig's sign was absent. Reflexes were present and equal. Babinski's test gave a bilateral plantar response. There was no motor weakness. The fundi were normal, and movement of the globes was full. In view of the absence of localizing signs, it was decided to investigate him more fully before operating. During the night he had a further rigor, the temperature rising to 103° F., and the pulse-rate to 80. He was seen by Lt. Col. Paul Wood, who found nothing apart from a tender and probably enlarged liver, a relatively slow pulse, and a few rhonchi. Investigations performed to arrive at a conclusive diagnosis resulted as follows:—

X-Ray of Chest—heart and lungs showed no abnormality.

X-Ray of liver region—probably some, but not grave, enlargement.

X-Ray of sinuses—all sinuses clear.

X-Ray of mastoids—right mastoid of poorly developed cellular type but outlines lost in general opacity. Relative rarefaction in region of mastoid antrum. Sinus plate appears intact.

Stool—no cysts found.

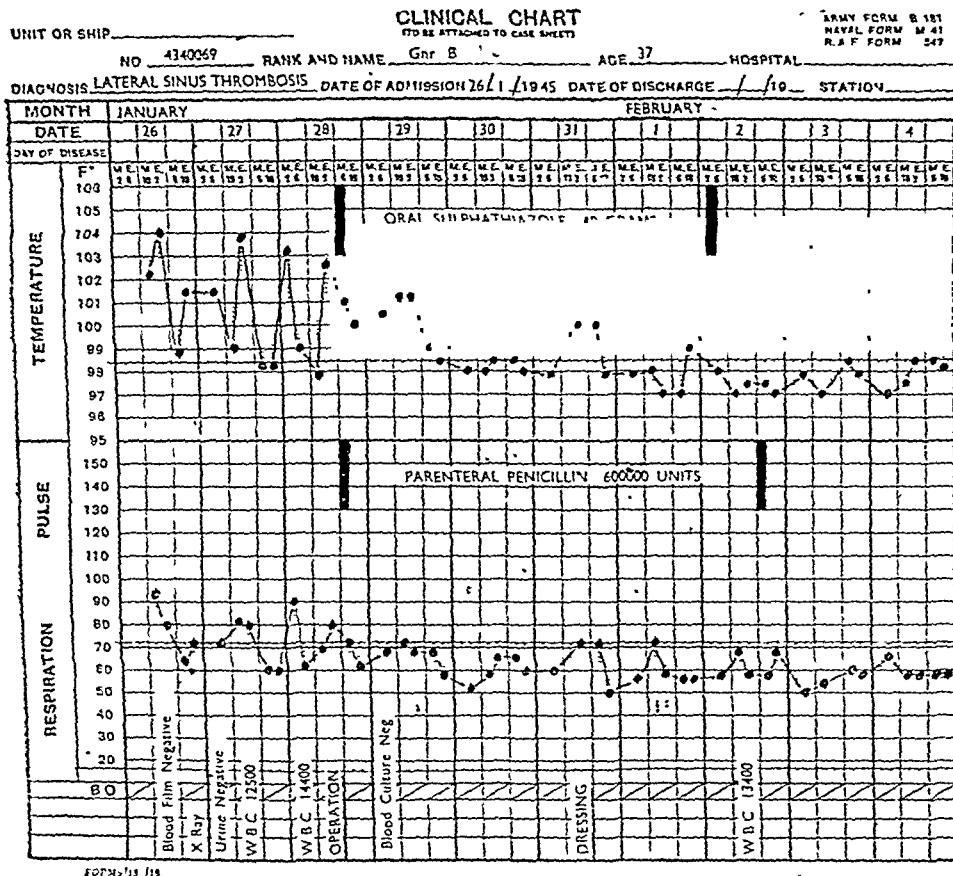
White cell count—12,500 per c. mm.—polymorphs 75 per cent., lymphocytes 22 per cent., monocytes 3 per cent.

Urine—no bile salts or pigments; urobilin—no excess; albumen—distinct cloud; no red blood cells or casts.

# Clinical Records

As these investigations excluded frontal sinusitis and general medical conditions, he was taken to the theatre on January 28th, and a general endotracheal anaesthetic given.

Lumbar puncture revealed clear fluid under slightly increased tension. Tobey-Ayer test gave a partial response on the right side. The fluid was sterile and contained 3 lymphocytes per c. mm. Protein content was normal.



The right mastoid was opened through a post-auricular incision and a few drops of pus were found in the region of the mastoid antrum. The antrum and the attic were filled with cholesteatoma. The tegmen tympani had been eroded. The dura mater was soft and appeared healthy. The sinus plate was intact, but in view of the rigors, it was decided to expose the sinus. On opening the plate, the sinus was found to be thrombosed and foul-smelling. It was opened and free bleeding obtained from the upper end which was packed. No hemorrhage was obtained from the lower end which also was packed off. The cavity was packed with Eusol, and the wound left open. The jugular vein was not tied.

## J. F. Birrell

On returning to the ward he was put on a course of parenteral penicillin, 15,000 units being injected intramuscularly every three hours until 600,000 units had been given. Simultaneously he was given sulphathiazole by mouth until 40 gm. had been administered.

Culture from the mastoid antrum was reported to be a pure growth of *P. vulgaris*. Blood culture was negative.

For the first two days after operation his temperature returned slowly to normal while his pulse-rate settled to about 60. The wound was dressed on the fourth day under gas and oxygen anaesthesia, and again on the ninth day under pentothal anaesthesia. On the latter occasion no bleeding was found on removing the sinus pack.

Culture taken from the mastoid antrum at the first dressing yielded a profuse pure growth of *B. proteus*. In view of this 1 per cent. neutral proflavine in sulphathiazole powder was introduced into the cavity at subsequent dressings until February 14th when he was again taken to the theatre, the radical operation completed, and the wound closed.

Temperature and pulse remained normal after the third day, liver tenderness disappeared and his appetite returned. He was allowed up on the thirtieth day after his original operation. The cavity was dressed in the usual manner, granulations being taken down as they occurred. On April 9th the cavity was healed and dry and he heard a whisper at 5 ft. in the right ear. He was discharged from hospital on April 25th when he heard a whisper at 10 ft. in the ear.

### Summary

A case is described of lateral sinus thrombosis due to *B. proteus*, treated by operation, penicillin and sulphathiazole therapy and proflavine powder locally, with recovery.

It is difficult to assess whether recovery is due to surgery ; to penicillin to which the organism is insensitive (Garrod, 1944) ; to sulphathiazole; to local application of proflavine powder ; or to the fact that the blood culture was sterile. My own view is that the absence of septicæmia was probably the most important factor.

I have to thank Col. C. H. K. Smith, O.B.E., M.C., and Col. A. S. Pern, O.B.E., T.D., Officers Commanding a General Hospital in the Central Mediterranean Force for permission to forward these notes. I am indebted to Major J. A. Pitt Evans, R.A.M.C., Pathologist to the Hospital, for his close co-operation.

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# The Journal of Laryngology and Otology

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## OTOLARYNGOLOGY IN THE ARMY: A REVIEW OF 4½ YEARS IN THE MIDDLE EAST.

By R. B. LUMSDEN, Lt.-Col., R.A.M.C.

THE termination of 4½ years' service abroad warrants a review of the work done during that tour of duty. The writer spent eighteen months in Palestine, followed by three years in Egypt, where the general hospital in which he worked had Neuro-Surgical, Maxillo-Facial and Chest Units attached. During the latter 2½ years, all otologists in the Command were visited on repeated occasions and he was in touch with everything pertaining to Otolaryngology in the Middle East Force.

It has not been found possible to retain complete records throughout the entire period, but those covering 3½ of the 4½ years are complete in most respects. Craig (1941), Collins (1943), Reeves (1943) and Birrell (1944) have reviewed their work in the Army, and the latter has correlated his figures with those of the other authors mentioned. In this present communication it is not intended to present a comprehensive statistical report, but many figures are quoted which would appear to be of interest, and discussion on a number of the subjects dealt with is based on these figures. Certain more general considerations will form the basis of a separate communication. For statistical purposes the periods covered are from January, 1941 to December, 1942 inclusive, and from July, 1943 to December, 1944 inclusive, unless otherwise stated (3½ years).

### Out-Patient Department

The total number of consultations was 7,985.

The total number of new patients was 5,734, of which 4,248 were out-patients and 1,486 were referred from other departments. Of the

total, 2,814 (49 per cent.) were *aural* cases, 1,699 (29·7 per cent.) were *nasal* cases, 688 (12 per cent.) suffered from a *throat* condition and 97 (1·7 per cent.) had an affection of the *larynx*, etc. Examination was negative in 436 cases (7·6 per cent.).

Chart 1 shows the quarterly total numbers of consultations and new patients occurring in *one* hospital.

Chart 2 shows the quarterly totals occurring in *all* the hospitals in the Middle East during the *latter* period recorded on Chart 1. Quarterly admissions to hospital are also shown. Such factors as variations in

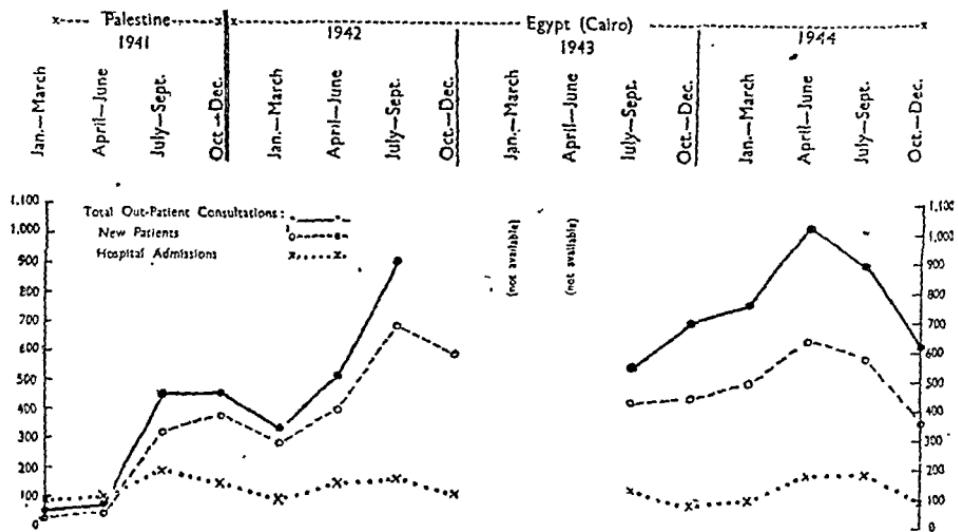


CHART 1.  
Showing quarterly figures of *one* hospital.

local conditions and local fluctuations in the size of army population must be kept in mind, but the rises during the summer quarters shown in Chart 1 are worthy of note. Their significance will be seen later.

#### Hospital Admissions

The total number of admissions was 1,868. Some patients suffered from more than one complaint and the following figures are therefore based on the number of diseases diagnosed, which totalled 1,906. Of this total, 1,147 (60·2 per cent.) had an *aural* disease, 480 (25·2 per cent.) had a *nasal* disease, 232 (12·2 per cent.) suffered from a *throat* condition, and 47 (2·4 per cent.) had an affection of the *larynx*, etc.

Table I shows the total number and percentage incidence of admissions to *one* hospital on account of some common conditions :—

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TABLE I. (Admissions to one hospital.)

Disease.	Total No.	% of total.	% of aural conditions.	% of nasal conditions.
Otitis externa .. ..	354	18.5	31	
Acute otitis media .. ..	370	19.4	32	91%
Chronic otitis media .. ..	325	17	28	
Acute sinusitis .. ..	159	8.3		33
Chronic sinusitis .. ..	111	5.8		23
Nasal polypi .. ..	20	1		4
Chronic tonsillitis-tonsillectomy .. ..	214	11.2		60%
Adenoids .. ..	8	0.4		
		81.6		

Chart 3 shows the quarterly incidence of admissions on account of otitis externa, and acute and chronic otitis media occurring in one hospital,

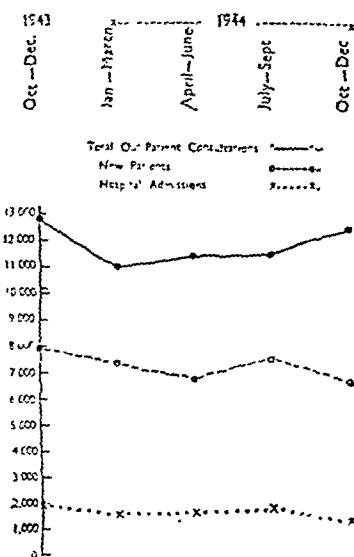


CHART 2.  
Showing quarterly figures of all hospitals in M.E.F.

while Chart 4 indicates the total quarterly admissions for the same conditions, to all the hospitals in the Middle East during the latter period recorded on Chart 3.

*Otitis Externa*: The high summer incidence is obvious from both Charts 3 and 4; and remembering that the figures refer only to admissions to hospital, an indication of the frequency and severity of this condition is obtained. The condition as found in that part of the world has been briefly discussed by Collins (1943); and at greater length by Daggett (1942). Quayle (1944) describes experience in New Guinea and Senturia (1944) discusses etiology. These articles are commended to otologists proceeding overseas.

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It became my routine to institute treatment for seborrhœa of the scalp during the later resolving stages of the otitis. It was latterly observed that the condition affected recent arrivals rather than "seasoned" troops. The high incidence shown in July—September, 1941 (Chart 3) lends some support to this observation, though otitis externa is apparently common among the native population. Swimming, either in sea or fresh water, is undoubtedly an etiological factor, but I do not regard it as one of prime importance in this condition.

*Acute Otitis Media*: The summer incidence is again illustrated in Charts 3 and 4. It is not proposed to enter into a lengthy discussion of

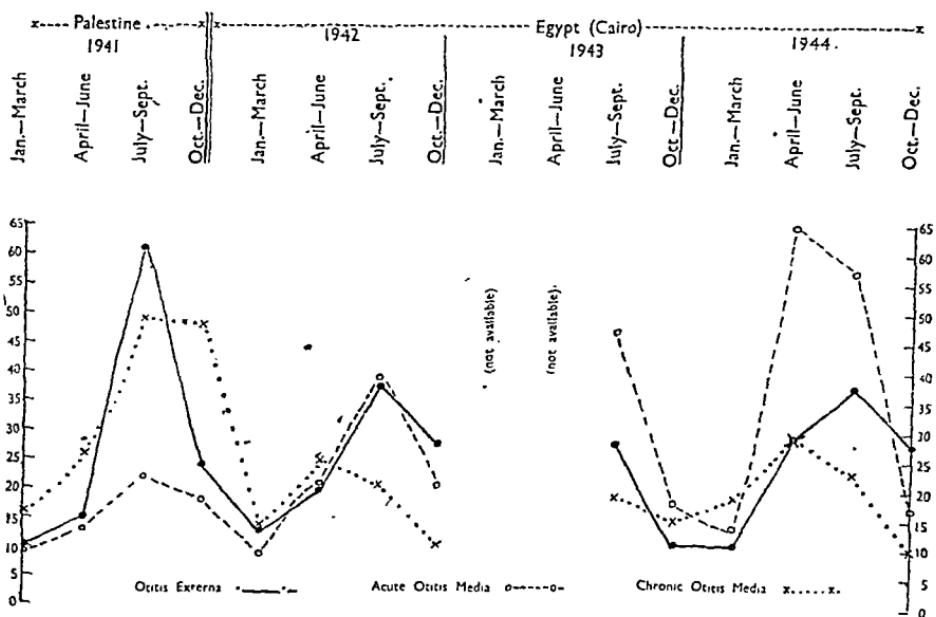


CHART 3.  
Showing quarterly admissions to one hospital.

the etiological importance of swimming pools, but attention is directed to a few points:

In Chart 3, the curve for 1941 relates to a hospital situated where swimming pools were few and far between; sea-bathing facilities were available, however. Conversely, the curves for 1942-3-4 relate to a hospital which was situated where very ample fresh water swimming pool facilities were increasingly available. While the percentage incidence among the large numbers of personnel frequenting swimming pools was apparently small (under 1 per cent.), I reported in July, 1944, "that very few out of the total of 65 cases of acute otitis media and the 19 cases of acute sinusitis admitted to this hospital during the period April—June had *not* been swimming within a brief time of the onset of

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their infection". Endogenous infection would appear to play an important role in etiology—"in an appreciable proportion of these cases, the patient stated that he went swimming while suffering from a 'cold'". Diving must present considerably greater risk than usual in these circumstances. It must be appreciated that in a hot climate a cold causes no disinclination to go swimming, possibly the reverse. In addition to the risk of aggravating their own infection, these sufferers will obviously provide an ample source of infection for others.

Nielsen (1945) concludes that "bathing otitis is an endogenous infection, and impure bathing water has no etiological significance".

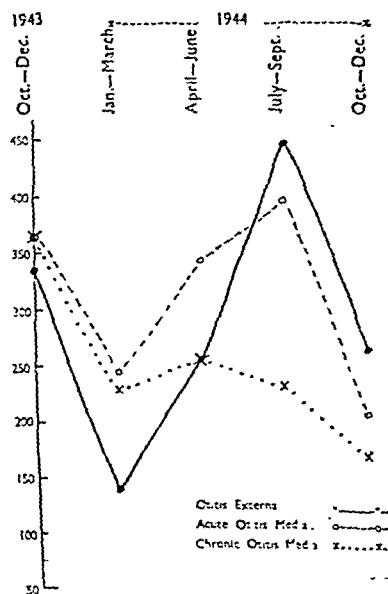


CHART 4.  
Showing quarterly admissions to *all* hospitals in M.E.F.

and that "cooling and local lesions of the mucous membrane must be considered as extraordinarily important factors". He finds that pneumococci are predominant; and in my experience pneumococcal infections were very common.

Concerning the use of the sulphonamides; by the time expressions of authoritative opinion began to appear in the literature, there was general agreement among army otologists in the Middle East that they should be used with caution. A limited experience of parenteral penicillin has given encouraging results.

*Chronic Otitis Media.* Experience in the army confirms the opinion that it is one of the problems which the Health Service must tackle at the earliest possible date. This subject will be dealt with more fully

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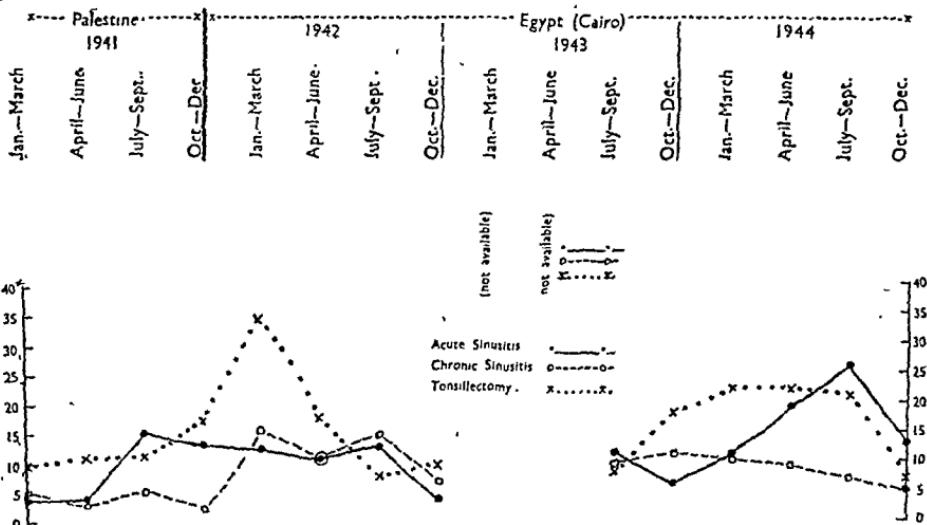


CHART 5.  
Showing quarterly admissions to *one* hospital.

elsewhere. The large number of chronic otitis media *admissions* during the latter half of 1941, as shown in Chart 3, had no significance other than service exigencies (Syrian campaign).

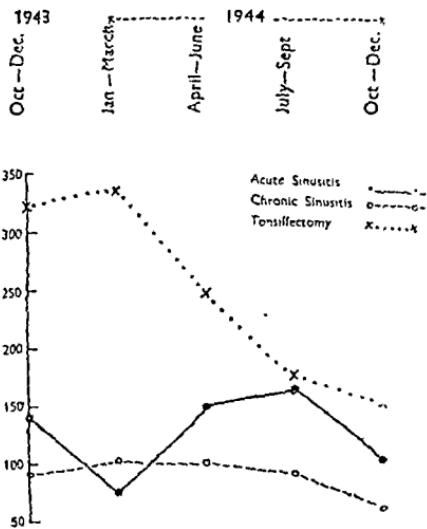


CHART 6.  
Showing quarterly admissions to *all* hospitals in M.E.F.

Chart 5 shows the quarterly incidence of admissions for acute and chronic sinusitis and for tonsillectomy to *one* hospital; Chart 6 indicates the total quarterly admissions for the same conditions to *all* the hospitals in the Middle East during the *latter* period recorded in Chart 5.

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*Acute sinusitis.* During 1944, a summer rise in the admission rate is appreciable (Chart 5). The etiological importance of swimming pools has been referred to, along with acute otitis media. Resolution was generally slower than in the home climate.

I agree with Collins (1943) concerning the frequency of "vacuum" sinus headache associated with sinus tenderness and marked redness and dryness of the middle turbinate mucosa. These cases most frequently follow in the wake of the hot day wind, which blows off the desert in spring and autumn for periods lasting several days ("Khamsin"). It is possible that the condition may be allergic in origin, but the clinical features do not resemble those commonly associated with "vasomotor rhinitis". Conservative measures are the key-note in treatment, but again resolution was frequently slow.

*Chronic Sinusitis:* Results from limited local use of penicillin have so far been unconvincing. The opinion is held that, on the whole, the climate is not one which is beneficial to upper respiratory infections, either acute or chronic.

(The high incidence of tonsillectomies during January/March, 1942 cannot now be accounted for. Reference to Chart 1 shows a low total admission rate during that period.)

## Operations

The total number of operations performed was :—

1941	1942	1943	1944	— Total (in one hospital).
167	225	194	264	850

Details are available for the *first and last fifteen months only*.

*Acute Mastoiditis:* During the fifteen months from January, 1941 to March, 1942, 71 cases of acute otitis media were admitted to one hospital, of which 22 (31 per cent.) required a cortical mastoid operation; whereas during a similar period from October, 1943 to December, 1944 171 cases were admitted, of which only 15 (8·7 per cent.) required operation. (See Table II.)

TABLE II.

	One hospital			All hospitals in M.E.F Oct., '43—Dec., '44
	Jan., '41—Mar., '42	Oct., '43—Dec., '44	Oct., '43—Dec., '44	
Admitted with acute otitis media .. .. ..	71	171	1,561	
Mycrotomy .. ..	5	26	198	
Cortical mastoidectomy ..	22 (31%)	15 (8·7%)	258 (16·5%)	

Undoubtedly one of the most important factors in this large discrepancy concerns the *time of admission to hospital*. During the former period, cases were arriving late—few were seen before the commencement

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of discharge and in most of these on which the cortical operation was performed, this was found necessary on or very soon after admission. On the other hand, during the latter period, very few cases had had symptoms for more than 48 hours prior to admission.

During the earlier period, sulphanilamide was being used fairly indiscriminately and the contra-indications and dangers in the later stages came to be appreciated. In many cases, it had been given in the early stages, prior to coming under the care of an otologist. In the latter period, the sulphonamides (chiefly sulphathiazole) were used with caution and only in cases which were seen early. It was not continued indefinitely in the absence of evidence of improvement.

*Radical and Modified Radical Mastoid Operations:* Personal and economic considerations facilitate retention of the soldier in hospital until after-treatment is quite complete. This is particularly important in this type of case, in which after-treatment was invariably carried out personally. War circumstances for long necessitated dealing with all such cases on the spot instead of sending them home. During the same 2½ years, 24 Radical and 8 attico-antrotomy operations were performed; all but 4 were discharged from hospital with healed dry cavities.

*Other Operations* performed during the same period of 2½ years (January, 1941—March, 1942 and October, 1943—December, 1944) included :—

#### Ear :

Removal of aural polypi and granulations .. .. .. .. ..	31
Labyrinth operation—Hinsberg .. .. .. .. ..	1
Neumann .. .. .. .. ..	1
Exploration of lateral sinus and ligation and division of internal jugular vein .. .. .. .. ..	1
Cerebellar abscess—drainage .. .. .. .. ..	2
Exploration of facial nerve .. .. .. .. ..	3

#### Nose :

Submucous resection .. .. .. .. ..	78
Turbinotomy .. .. .. .. ..	6
Removal of polypi and/or intranasal ethmoid .. .. .. .. ..	29
External ethmoid (—osteoma) .. .. .. .. ..	1
Antrostomy—intranasal .. .. .. .. ..	33
Caldwell-Luc .. .. .. .. ..	13
Intranasal frontal .. .. .. .. ..	2
External frontal drainage .. .. .. .. ..	2
Frontal obliteration .. .. .. .. ..	2

#### Throat :

Tonsillectomy .. .. .. .. ..	173
Removal of adenoids .. .. .. .. ..	8

#### Endoscopy :

Direct Laryngoscopy .. .. .. .. ..	23
Bronchoscopy .. .. .. .. ..	6
Œsophagoscopy .. .. .. .. ..	7
Mediastinal drainage .. .. .. .. ..	1

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## Complications

The otitic and nasal complications occurring in *one* hospital during four complete years are shown in Tables III and IV. Brief summaries of these cases are given later.

TABLE III.

### OTITIC COMPLICATIONS (JAN., 1941—DEC., 1944).

	Total	Recovered	Died
A S O M.—Meningitis .. .. ..	3	2 (1 fractured skull)	1
A S O M.—Lateral sinus thrombosis .. ..	1	1	0
C S O M.—Lateral sinus thrombosis .. ..	2	1	1 (cavernous sinus thrombosis)
C S O M.—Otitic septicaemia .. ..	2	1	1
	5	3	2
C S O M.—Temporo-sphenoidal abscess :			
1 Drainage through mastoid .. ..	2	1	1
2 Aspiration through burr hole ..	1	1	0
3 Aspiration through mastoid, followed by excision .. ..	1	1	0
	4	3	1
C S O M.— <i>Labyrinthitis</i> .			
1 Circumscribed .. .. ..	2	2 (1 Hinsberg operation)	0
2 Diffuse serous .. ..	1	1 (post-operative)	0
3 Manifest diffuse purulent—Neumann operation	2	2 (1 post-operative)	0
	5	5	0
C S O M.— <i>Multiple complications</i> .			
1 Diffuse purulent labyrinthitis (panlabyrinthitis) lateral sinus thrombosis, meningitis	1	0	1
2 Diffuse purulent labyrinthitis (panlabyrinthitis) cerebellar abscess (— drainage)	1	0	1
3 Lateral sinus thrombosis (organized) cerebellar abscess (— drainage) meningitis ..	1	0	1
	3	0	3

*Caloric Vestibular Tests*: Since the publication by Fitzgerald and Hallpike (1942) of their technique, this has been adopted in all such investigations.

TABLE IV.

### NASAL AND PARANASAL SINUS COMPLICATIONS

(JAN., 1941—DEC., 1944).

	Total	Recovered	Died
1 Nasal carbuncle, Cavernous sinus thrombosis	1	0	1
2 Chronic pansinusitis, external frontal op., frontal lobe abscess, aspiration, excision	1	1	0
3 Frontal osteomyelitis .. .. ..	2	2 (1 fractured skull)	0

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Table 5 shows the otitic complications which occurred in all hospitals in the M.E.F. during a period of 15 months.

TABLE V.

OТИIC COMPLICATIONS—ALL HOSPITALS IN M.E.F.  
(Oct., 1943—Dec., 1944)

	Total	Recovered	Died
A.S.O.M.—Meningitis	.. .. .. .. 3	1	2
C.S.O.M.—Meningitis	.. .. .. .. 4	4	0
	—	—	—
	7	5	2
A.S.O.M.—Lateral sinus thrombosis	.. .. 2	1	1
C.S.O.M.—Lateral sinus thrombosis	.. .. 2	1	1
S.O.M.—unspecified lateral sinus thrombosis	.. 1	0	1
C.S.O.M.—Otitic septicaemia	.. .. 1	1	0
	—	—	—
	6	3	3
A.S.O.M.—Temporo-sphenoidal abscess	.. .. 2	0	2
C.S.O.M.—Temporo-sphenoidal abscess	.. .. 1	1	0
	—	—	—
	3	1	2
C.S.O.M.—Cerebelloar abscess	.. .. .. 2	0	2
	—	—	—
<i>Labyrinthitis :</i>			
1. Circumscribed .. .. .. .. 3	3	0	0
2. Diffuse Serous .. .. .. .. 3	3	0	0
3. Manifest diffuse purulent—Neumann operation .. .. .. .. 2	2	0	0
	—	—	—
	8	8	0
	—	—	—

*Hysterical and Simulated Deafness:* Complaints of complete deafness, bilateral or unilateral, were rare. No cases were encountered during the Western Desert campaigns, and none were found among Europeans. In the case of one Palestinian, hearing was re-established under light evipan anaesthesia. Bilateral simulation was encountered in a Sudanese, who was due for a court martial. I agree with Collins (1944), however, that there is sometimes a psychological element which leads to an exaggeration of symptoms based on an underlying organic lesion. This was particularly noticeable in fighting Indian troops.

*Nasal Allergy:* A mild degree of this condition was very common, but severe cases were relatively rare. There appeared to be no particular seasonal incidence. The writer suffered from hay fever at home, but in Palestine and Egypt experienced only mild symptoms for one or two days at a time, at any time of the year. One attack lasted a week during the orange blossom season and it was associated with bronchial asthma. It has returned with full vigour on returning home this summer.

*Atrophic Rhinitis* was not very common. Most sufferers had had previous symptoms at home, but in hot weather the condition became intolerable both to themselves and frequently to their associates. It was

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found necessary to return all but the mildest cases to a temperate climate. Generally speaking, turbinotomy should *not* be carried out on persons who are likely to be proceeding to a hot, dry, climate.

*Diphtheria* : It came to be generally recognized that diphtheria in the Middle East is a much more dangerous disease than is generally the case at home. Neuritis was common and frequently extensive. The phlegmonous type was frequently seen ; it resembles quinsy, with early severe adenitis, but the faacial swelling tends to be more diffuse than in a true quinsy. Membrane may be absent and swabs may be negative for several days after this condition is established. In one such case, in which altogether 160,000 units of serum were given within 48 hours of the onset of illness, there was subsequent involvement of IIIrd Vth, VIIth, IXth and Xth cranial nerves ; there was respiratory embarrassment at times, and feeding by nasal intubation was required for three weeks. All four limbs were also affected. He eventually made a good recovery. Incision of the supposed quinsy may lead to disastrous results in such cases.

*Injuries to Larynx* : Three cases of laryngeal trauma have already been recorded (Lumsden, 1942 ; Lumsden and Weir, 1945).

*A Leech in the Trachea* was encountered in a Palestinian Arab who had been drinking direct from a " Wadi ". The patient himself suggested the probable cause of his discomfort and haemoptysis. Under local anaesthesia, with the table inverted, detachment was effected by direct application of 10 per cent. cocaine to the leech, which then rolled into the bronchoscope.

A case of *Mediastinitis* with abscess formation and eventual recovery is being recorded separately.

*Leprosy* : No cases were encountered among service personnel, but during a visit to Cyprus a visit was paid to the Government Leper Farm, where many of the cases were examined.

*Other conditions of interest* which were encountered were —

Two cases of hereditary nasal telangiectasia.

Two cases of rhinolith, a small button forming a core in one.

Rhinosporidiosis, diagnosed histologically, in an Indian.

Unilateral choanal atresia in a male child aged 6 months.

Two cases of cancellous osteoma—one in the ethmoid, the other in the maxilla. Solitary plasmacytoma of the maxilla in a Libyan Arab.

A retropharyngeal tumour in a boy aged 18, causing respiratory embarrassment ; subsequently shown to be lymphadenoma.

Advanced tuberculous laryngitis (proved histologically) in a man of 59 with a positive Wassermann.

Two cases of recurrent multiple papillomata of the larynx, aged 21 and 38.

Two cases of intrinsic carcinoma of the larynx. Bilateral vocal cord paralysis with recovery, in a case of Typhus.

Carcinoma of the lower oesophagus in a youth aged 23.

### War Wounds and Accidental Injuries

Stallard (1944) observes that "the formation of Special Centres has obscured the forgotten Cinderella, eye surgery. M.O.'s sorting convoys direct eye wounds to one of these and much work arrives second-hand with some delay in transfer". These observations, with modifications, might also be applied to otolaryngology. Experience indicates, however, that the majority of such cases *should primarily* be directed to the Special Centres *but* that the co-operation and help of the Ear, Nose and Throat Specialist should be sought *early and often*. This co-operation must be more than nominal—it must be factual. As the war progressed, it was found that this policy was increasingly, if gradually accepted, to the advantage of all concerned.

In recording a small series of cases, attention has again been drawn to the importance of otological examination in cases of head injury (Lumsden and Fleming, 1944). If for no other purpose, this seems most desirable in respect of possible pension or compensation entitlements.

### BATTLE CASUALTIES

Table VI gives an analysis of E.N.T. battle casualties. Battle casualty E.N.T. admissions formed 3 per cent. of all E.N.T. admissions to one hospital. The majority of the aural cases suffered from effects of blast.

TABLE VI.

#### E.N.T. BATTLE CASUALTIES (ONE HOSPITAL)

(JAN., 1941—DEC., 1942 AND JULY, 1943—DEC., 1944).

		Admissions	Out-Patients	From other Depts.
Ear .. . ..	.. ..	33	53	76
Nose .. . ..	.. ..	24	0	29
Throat and neck ..	.. ..	2	1	4
Total ..		59 (3%)	54	109

*Wounds involving the Paranasal Sinuses*: A separate communication is based on 20 such cases (Lumsden, 1945).

*Wounds involving the temporal bone*: Only four cases came under my direct care. They presented no features requiring particular comment.

*Ear injuries from blast*: Recent American literature contains a number of articles on this subject. Recent literature in this country includes communications by Suggit (1943) and Collins (1944). The former describes the audiometric findings in 69 ears damaged by gun-fire, and defines the varieties of audiometric abnormality. The latter found that

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20 per cent. of 885 battle casualties of all types sustained some aural trauma. Audiometric examination was, for us, impracticable, but tuning fork tests indicated that the incidence of mixed inner and middle-ear deafness associated with rupture of the tympanic membrane was considerable. Collins found mixed deafness in 40 per cent. of such cases.

*Infection following drum rupture:* Collins (1944) found middle-ear infection present in 22 per cent. of traumatic perforations. The incidence has been found to vary enormously. How this can come about is exemplified in the case of one hospital, where it was found that among 26 cases of ruptured drum, 81 per cent. had a super-added otitis media. In actual fact, *because* of this infection, which was likely to render them unfit for duty for some weeks, these cases were specially "weeded out" at different centres and sent several hundred miles to that particular hospital. Considerable attention was given to this problem of secondary infection, and undoubtedly the most obvious and preventable cause is unwarranted interference. Few medical officers seem able to resist the temptation to attack an offending ear with a syringe, in spite of oft-repeated exhortations to the contrary. It is suggested that this matter, which has proved so troublesome, should be given the strongest emphasis by teachers of otology. Even the insufflation of powders, such as sulphonamide, is thought to be contra-indicated. In one series of 100 perforations so treated from the day of occurrence, a high incidence of infection (38 per cent.) was found. A plug of cotton wool in the external meatus should be the only local procedure adopted. The potential danger of syringing wax from an ear which has recently been exposed to blast should be borne in mind. Deafness and discomfort may be due, not to impaction of wax, but to a ruptured drum behind the wax. In such circumstances, a scoop should be used for its removal. It has not been possible to assess by controls, the value of prophylactic or therapeutic oral administration of sulphonamide. Collins (1944) points out that infection may be caused by an associated otitis externa and the following case is a good illustration of this: An officer was evacuated to hospital with a wound of the leg. A ruptured drum was present, but there was no infection. Three months after being wounded, he was still in hospital and was taking sulphathiazole, when he developed otitis externa. The drum had not healed, middle-ear infection rapidly followed and a cortical mastoid operation ultimately became necessary.

During the battle of El Alamein, I was enabled to examine the ears of 138 cases (276 ears) suffering from head wounds, soon after their admission to a Neuro-Surgical Unit attached to a general hospital. Twenty-six ruptured drums were found (bilateral in 5 cases) and middle-ear infection was present in 9 ears. Six cases had wounds involving the ear, while one case of long-standing chronic otitis media was encountered. All cases had sulphonamide from the time of admission; in 11 cases

with ruptured drums it had been given during evacuation from the time medical attention was first received. Of these 11, middle-ear infection was present in 4; 6 ears had been syringed or had had drops instilled, and all of these were infected.

*Follow-up* was possible in only 6 of the 9 infected ears. Two were dry and the drum healed, 3 were dry but not yet healed, and 1 ear was still moist at the time of the last examination. Tuning fork tests were practicable in only 15 cases of rupture; bone conduction was appreciably reduced in 7 of these. It was thought probable that the high proportion of infected ears in this series (34 per cent.) was contributed to by the inadvertent entry of fluid (soapy water, antiseptics) into the ear in the course of treatment of the head wound.

Contrary to general belief, the work of the otolaryngologist in the army—certainly in the Middle East—offered much that was interesting and instructive. Many problems were presented which scarcely exist in peace-time civil life.

A return to the life of residence in hospital does much to promote closer understanding between members of different departments and has helped one to realize more fully the restricted outlook which many of us are inclined to develop. This is exemplified in connection with traumatic lesions, such as fractures of the skull involving the ear or paranasal sinuses. It is commonly accepted that we have little or no part to play in this direction, yet traumatic lesions have formed a most important part of one's work in the army. Otolaryngologists themselves are not entirely responsible for this, but they are not exempt from criticism.

Cairns (1945) tells us that "the neurosurgeon should work in close collaboration with the maxillo-facial, oto-rhinological and ophthalmic surgeons". We must see to it that we do not fail to prove ourselves willing and able to take our proper place in such collaboration.

### Summary

1. A statistical analysis is presented, which covers a period of 3½ years, during which the total number of out-patient consultations amounted to 7,985. New out-patients totalled 5,734 and 1,868 ear, nose and throat cases were admitted to hospital.
2. Otitis externa, acute otitis media and sinusitis cases are reviewed with particular reference to seasonal incidence and the etiological role of swimming pools is discussed.
3. Operation figures are detailed and the significance of these relating to operations for acute mastoiditis is discussed.
4. Otitic and paranasal sinus complications are recorded. Brief summaries of case records are appended.

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5. Comments are made on functional deafness, nasal allergy, atrophic rhinitis and diphtheria, and a number of interesting and unusual cases are referred to.

6. The role of the otolaryngologist in relation to war wounds and accidental injuries is briefly considered, and figures are given.

7. Ear injuries resulting from blast are discussed and the results of examination in 138 cases suffering from head wounds are recorded.

## Acknowledgments

The names of those to whom I should like to express thanks are too numerous to mention. They include the otologists in the M.E.F., the Commanding Officers and staffs of Nos. 23 (Scottish) and 15 (Scottish) General Hospitals, members of No. 1 M.N.S.U., No. 2 M.F.U. and No. 1 Surg. Chest Team. Two names require special mention : Captain C. D. Weir, M.C., who helped me with much of the work during the latter two years, and Corporal G. McCart, who carried out much of the routine work of the department and who prepared the records from which many of the figures have been obtained.

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## Case Summaries

### MENINGITIS :

1. Dvt. M., 35. (June, 1942) : A.S.O.M. (R. and L.), sulphapyridine. Meningitis (C.S.F. culture : no growth). Myringotomy R. and L. Recovery : Ears dry, hearing normal.

2. Sgt. S., 26 (Sept., 1942) : Fracture of L. middle cranial fossa, with bleeding from L. ear.—A.O.S.M. (L.)—mastoiditis and meningitis. I-V sod. sulphadiazine, L. cortical op. with free removal of bone in fracture line. Recovery : Ear dry, some residual deafness.

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3. — M. (1944): A.S.O.M. (R. and L.)—Meningitis. Sulphadiazine and penicillin. Myringotomy R. and L. (Cultures—aural swab and C.S.F.: pneumococcus.) *Death* within 36 hours of onset of otitis media.

## LATERAL SINUS THROMBOSIS:

1. P.O.W. C. (1943): A.S.O.M.—Mastoiditis—Sinus thrombosis. Cortical operation and lateral sinus opened. *Recovery*.

2. Pte. P., 35 (July, 1941): C.S.O.M. (L.) with acute exacerbation—Bezold mastoiditis. L. Cortical op. (incomplete owing to ether convulsion) and drainage of Bezold abscess (Culture: no growth). Sulphanilamide. Lateral sinus and int. jugular vein thrombosis. No malaria parasites found. Sinus opened and vein ligated and divided (Cultures—blood and excised sinus wall: no growth). *Cavernous sinus thrombosis.—Death*.

3. Pte. W., 21 (May, 1944): C.S.O.M. (R.) following blast injury in action acute exacerbation. *Op.* 1 R. Cortical op. (Capt. Weir) perisinus abscess, wound unsutured (Culture: Coliform bacilli). Lateral Sinus and int. jugular vein thrombosis. No malaria parasites found. *Op.* 2, sinus opened and vein ligated and divided (Capt. Rees). Blood culture: no growth. Symptoms and signs of *petrositis*—Radical op. (op. 3) post-labyrinthine petrous fistula. *Recovery*. Cavity healed and dry. Returned to U.K.

## OTITIC SEPTICAEMIA:

1. Pte. M., 31 (March, 1943): C.S.O.M. (L.) with acute exacerbation. "Aseptic" meningitis—controlled with sulphapyridine. Case transferred. L. cortical op. (Culture: no growth). Developed rigors and swinging temperature. No malaria parasites found. Blood culture—no growth. Spontaneous rupture of sigmoid sinus—packed off. Transfusion and infusion and I-V sod. sulphadiazine. Developed pneumonia and empyema (Culture: no growth). *Death*. P.M.—Rt. empyema. No ante-mortem clot in lateral sinus, jugular bulb or vein.

2. Capt. H., 35 (June, 1944): C.S.O.M. (R.) with acute exacerbation. R. cortical op. (Major. Highmoor). No malaria parasites found. Blood culture: haemolytic strept. Sulphathiazole. ? brain abscess. Case transferred. Cultures: mastoid swab and blood: haemolytic strept., penicillin-sensitive. ? sinus thrombosis. In collaboration with Major Lewin, neurosurgeon, given penicillin: I-M drip—660,000 units in 5 days, followed by I-M injection (15,000 units 3-hourly)—585,000 units in 5 days. Blood culture negative 48 hours after commencement. *Recovery*. Dry perforation, some residual deafness.

## TEMPORO-SPHENOIDAL ABSCESS:

1. Bdr. T., 36 (Jan., 1943): C.S.O.M. (L.). (Dry radical mastoid cavity—R.) L. Radical op. (Capt. Rees). Case transferred with signs of abscess. L. Temporo-sphenoidal abscess drained through mastoid, I-V sod. sulphadiazine. Meningitis, *death*. P.M.—Basal meninigitis, drained temporal lobe abscess, ventriculitis.

2. Spr. A., 29 (April, 1943): C.S.O.M. (R.). Radical op. at age of 15. History of fits. Now acute exacerbation. Exploration of radical mastoid—"leaking" temporo-sphenoidal abscess found, with dural fistula—drained. I-V sod. sulphadiazine. Secondary suture 4 weeks later. *Recovery*. Mastoid cavity remains moist.

3. Gnr. C., 22 (April, 1943): C.S.O.M. (R.), with acute exacerbation. R. cortical op., wound unsutured (Capt. Magill). Culture: non-haemolytic strept. ? abscess—case transferred. Needle exploration through middle fossa dura failed to locate an abscess. I-V sod. sulphadiazine. Large abscess tapped during

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attempted ventriculography. Deeply situated abscess aspirated (twice) through temporal burr-hole (Major McKenzie, neurosurgeon). Culture: sterile. Recovery. Ear dry and healed, hearing poor. Returned to U.K.

4. Pte. J., 25 (March, 1944): C.S.O.M. (L.) with acute exacerbation. Sulphonamide (54 gm.) and subsequent L. cortical op. (Major Kilpatrick). ? abscess—case transferred. Radical op. and temporo-sphenoidal abscess aspirated through middle fossa dura and thorotrust injected. I-V sod. sulphadiazine. Secondary mastoid suture 14 days later. Excision of abscess through a temporal flap 8 weeks later by Major Lewin, neurosurgeon. Recovery. Mastoid cavity healed and dry. Returned to U.K.

## LABYRINTHITIS :

1. Capt. S., 42 (April, 1942): C.S.O.M. (R.)—circumscribed labyrinthitis. Sulphanilamide commenced 24 hours before radical op.—fistula found in horizontal canal. Recovery. Cavity healed and dry, but still slight unsteadiness on sudden movement two months after op. Returned to U.K.

2. Major B., 34 (March, 1943): C.S.O.M. (R.). R. facial paresis, (Weber to R., R. Rinne neg., hearing: C.V. close up). R. radical op.—cholesteatoma, fistula in horizontal canal, facial n. exposed by disease, bone dehiscence in floor of middle ear, over jugular bulb. Hinsberg labyrinth op. done in view of patient's occupation (surgeon). Recovery. Facial paresis completely recovered, slight persistent discharge.

3. Bdr. S., 34 (May, 1943): C.S.O.M. (L.). Radical op. 15 years ago. Clinical and X-ray diagnosis of *petrositis*. Radical cavity explored—infected cells and post-labyrinthine bone fistula present. Post-operative manifest diffuse purulent labyrinthitis—Neumann labyrinth op. Recovery. Cavity healed and dry.

4. L/Bdr. G., 30 (Dec., 1943): C.S.O.M. (R.). Old radical op. Symptoms and signs of *petrositis*, followed by manifest diffuse purulent labyrinthitis (Culture—pyocyanus). Radical cavity explored—post-labyrinthine cell-extension present, Neumann labyrinth op. done. I-V sod. sulphadiazine. Secondary suture 3 weeks later. Recovery. Cavity healed and dry. Returned to U.K.

## PETROSITIS :

Capt. P., 30 (Feb., 1944): C.S.O.M. (R.). Healing delayed after radical op. elsewhere, one year ago. Persistent discharge since. Clinical and X-ray diagnosis of *petrositis*. Radical cavity explored. Postero-superior bone fistula present. Recovery. Cavity healed and dry.

## FACIAL PARALYSIS :

Spr. T., 23 (Aug., 1941): A.S.O.M. (R.), mastoiditis, cortical op.—deep retro-facial cells. Immediate post-operative facial paresis. Nerve decompressed, resulting in immediate marked improvement, followed by relapse and subsequent gradual recovery. (Final result not known.)

## MULTIPLE COMPLICATIONS :

1. C.Q.M.S. R., 33 (April, 1943): C.S.O.M. (R.), mastoiditis and manifest diffuse purulent labyrinthitis. Patient very ill on admission. R. radical op.—*petrositis* and panlabyrinthitis. Hinsberg labyrinth op. I-V sod. sulphadiazine. Lateral sinus thrombosis and meningitis diagnosed, but patient unfit for further op. Death. P.M.—Meningitis, septic thrombosis of lateral sinus, *petrositis*.

2. Pte. H., 34 (Oct., 1943): C.S.O.M. (L.) with acute exacerbation. Diffuse purulent labyrinthitis and cerebellar abscess diagnosed. Became unconscious shortly after admission. L. radical op.—panlabyrinthitis, cerebellar abscess

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drained through Trautmann's triangle. I-V sod. sulphadiazine. Regained consciousness. No pus found on further exploration. *Death* 7 days later. P.M.—Multiple cerebellar abscesses.

3. Pte. S., 22 (Sept., 1944) : C.S.O.M. (R.) with acute exacerbation. R. radical op. (Sqdn. Ldr. Dermer). Meningitis and probable cerebellar abscess—case transferred and treated in collaboration with Major Lewin, neurosurgeon : C.S.F. culture : hæmolytic strept., penicillin-sensitive. Given sulphadiazine and penicillin I-M (15,000 units 3-hourly) and intrathecal (5,000 units daily). Meningeal signs resolved and *C.S.F. culture became sterile*. Cerebellar signs increased. Cerebellar abscess drained through Trautmann's triangle (Culture of pus : non-hæmolytic streptococcus, sulpha- and penicillin-resistant). *Death*. P.M.—organized thrombus in sigmoid sinus, petrositis, multiple cerebellar abscesses ; no evidence of meningitis.

## CAVERNOUS SINUS THROMBOSIS :

L.A.C. E., 20 (June, 1941) : Nasal carbuncle (no surgical interference), sulpha-pyridine, cavernous sinus thrombosis. Blood culture—Staph. aureus. *Death*. P.M.—Cavernous sinus thrombosis confirmed.

## FRONTAL LOBE ABSCESS :

L/Cpl. D., 30 (June, 1943) : Chronic pansinusitis (R.) with acute exacerbation of maxillary antrum. Subsequent intranasal antrostomy (Major Haigh) followed by R. frontal headache and oedema. Case transferred—given sulphanilamide and 24 hours later, R. external fronto-ethmoidal drainage (Howarth) op.—subperiosteal abscess with ethmoidal fistula. Ten days later, drowsy and confused—slowly progressive. ? abscess. C.S.F. normal. Local condition clinically and radiologically satisfactory. Sulphadiazine. Seven weeks after sinus op.—large R. frontal lobe abscess aspirated and thorotrust injected through a burr hole by Major McKenzie, neurosurgeon. Culture of pus : pneumococcus. Aspiration repeated 7 days later and excised 3½ months later, through R. frontal osteoplastic flap, by Major Hooper, neurosurgeon. *Recovery*. Returned to U.K.

## FRONTAL OSTEOMYELITIS :

I. F/O. B., 36 (Jan., 1944) : Subacute rheumatism-tonsillectomy 2.12.43, followed by acute maxillary sinusitis (R.). Developed oedema and tenderness in frontal region. R. Caldwell-Luc op. 26.12.43. Sulphadiazine. Case seen in consultation and transferred. X-ray : L. frontal sinus extends well to the R. of mid line, localized infection to R. of mid line with small sequestrum at upper margin. Pus aspirated, culture : Staph. albus only. Op. 1 : Bilateral frontal obliteration op. 8.1.44 : frontals communicate, pus under pressure, sequestrum of anterior wall of L. sinus, well to R. of mid-line. Pus in ethmoids (R. and L.) and L. antrum—exenteration of ethmoids and L. antrostomy. Sulphadiazine continued (total : 250 gm.). Culture : Pus : no growth. Bone : Staph. aureus. Satisfactory progress for 2 weeks, followed by recurrence of headache and raised temp. Abscess under scalp spreading upwards. X-rays : extending osteomyelitis, with sequestra. Op. 2 : bone removed extensively, exposing healthy dura, (24.2.44. (Capt. Northcroft)). Culture : no growth. X-ray 4 weeks after op. 2. Extensive osteomyelitis above area of resection and sequestrum of parietal bone. Further treatment in collaboration with Capt. Lewin, neurosurgeon. Penicillin I-M commenced 1.4.44. (15,000 units 3-hourly. Total : 2,610,000 units). Anaerobic culture : anaerobic hæmolytic strept., sulpha-resistant but penicillin-sensitive. Uninterrupted recovery thereafter. Successive X-rays showed definite

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arrest of disease followed by evidence of bone regeneration. Returned to U.K., May, 1944.

2. Spr. G., 26 (Aug., 1944). Multiple fractures of skull and face, involving paranasal sinuses—Jan., 1944. Treated by pin fixation (2.M.F.U.). In June, 1944, developed swelling in L. frontal region and, in another hospital, this was incised above the eyebrow, pus evacuated and sequestra removed. Transferred 4 weeks later, with large discharging fistula in L. frontal region, leading into frontal sinus. No history of C.S.F. rhinorrhoea, sense of smell present. X-ray: opacity and loss of outline of L. frontal sinus, with small sequestra. Opacity and sequestra—L. ethmoid. No evidence of fracture of inner table. Lipiodol injected into fistula passes down fronto-nasal duct. Culture: Staph. aureus, penicillin-sensitive. 30.8.44—obliteration of L. frontal sinus and exenteration of L. ethmoid. Penicillin I-M (15,000 units, 3-hourly. Total: 1,335,000 units). Subsequent discharge from medial angle of wound and a small sequestrum was later removed, after which the wound healed. X-ray 13.10.44: No evidence of sequestra or active infection. 20.11.44: Recurrence of swelling and discharge from wound. X-ray—bone erosion and small sequestrum present. Culture—Staph. aureus, penicillin-sensitive. Penicillin resumed (190,000 units). Small sequestrum removed a few days later, with subsequent healing. Recovery. Returned to U.K. Follow up—June, 1945: no further trouble.

# THE EFFECT OF SINUSITIS ON FLYING PERSONNEL

By G. H. BATEMAN (Wing-Commander, R.A.F.)

The object of this survey is to find out what the flying man complains of when he has sinusitis and what influence an attack of sinusitis has on his flying career. It is not to investigate sinus pains induced by flying. In other words, the object is not to investigate sinus barotrauma to evaluate the influence of infective nasal sinusitis past or present, on a man's flying career.

The cases studied were all seen at the Royal Air Force Central Medical Establishment and I have to thank Air Commodore Dickson for his kindness in giving me access to this material and allowing me to use it.

These cases have all been seen by either Air Commodore Dickson, or by me or by both of us. The cases coming to the Central Medical Establishment have all been previously seen by an Ear, Nose and Throat Specialist in R.A.F. Hospital and are referred to us only when they fail to respond satisfactorily to treatment, when a second opinion is required when some difficulty in disposal arises. They thus tend to be difficult unsatisfactory cases and the results of treatment are much worse than would be obtained from a group of cases of nasal sinusitis in airmen treated at any of the R.A.F. Hospitals. I was myself working at a civilian hospital till nearly two years ago and though no figures are available from hospital practice my conclusions are coloured by my experiences in hospital and by discussions with other R.A.F. E.N.T. specialists to whom the cases are referred direct from the Unit Medical Officer.

It must be realized that the flying man spends most of his time on the ground and the majority of cases of sinusitis behave in an entirely "grounded" manner. For example, an airman gets an acute naso-aryngeal infection and is off duty sick. This does not clear up and he develops symptoms of acute maxillary sinusitis. This is diagnosed and treated and in 2-3 weeks has cleared up and after a period of sick leave returns to full flying duty. The sinusitis has had no influence on his flying except to keep him grounded for a period, it produced no symptoms whilst flying and was not caused by flying. These cases of acute sinusitis which respond readily to conservative treatment are not referred to the Central Medical Establishment and thus do not come into this survey.

At the other end of the scale there are men who are flying with no symptoms referable to the sinuses and who, during investigation for a



FIG. I.



FIG. 2



FIG. 3.



FIG. 4.

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possible focus of sepsis, are found to have radiological opacity of a sinus. This is frequently a dome-shaped shadow on the floor of the antrum suggesting a polyp in the antrum. These cases are not uncommon and in the absence of symptoms and other clinical signs it is our practice to take no action in these cases. By itself, the presence of a dome-shaped shadow in the antrum does not mean that the possessor will get symptoms referable to his sinus when he flies. These cases are not included in this survey. We are thus left with a group of men who have symptoms referable to their sinuses, who have clinical and radiological evidence of sinusitis and who are flying personnel.

We have examined and diagnosed as sinusitis 156 cases in flying personnel during the period under review and I have attempted to sort out and analyse their case histories. During the same period 30 men were seen with pains referable to the sinuses during flying but in whom no evidence of sinus pathology past or present was found. These 30 men were cases of sinus barotrauma without any predisposing sinusitis. I do not propose to discuss them, but mention them only to give some idea of the relative importance of this condition which has perhaps received undue emphasis at times.

The symptoms of the 156 cases have been analysed according to the onset, and the ultimate disposal of each group has been recorded. These are shown in Table A where 68 men complained of symptoms in the air only, 62 men complained of symptoms in the air and on the ground and 25 men complained of symptoms on the ground only.

Group 1 consists of men who had no symptoms unless they flew, but who had symptoms referable to the sinuses which were caused by flying. They also had clinical or radiological evidence of sinusitis and the symptoms were considered to be caused by the sinusitis.

Group 3 consists of men whose symptoms occurred on the ground but these were not of sufficient severity to cause them to be grounded. During flight these symptoms were aggravated or additional ones appeared.

Group 2 consists mainly of men whose symptoms developed on the ground, and were of such a nature that they were grounded until treatment was completed. But it also includes a number of men whose symptoms were present on the ground and these symptoms were completely unaffected by flying, though they may have persisted during flight.

The Table B is an analysis of the symptoms. Four symptoms were complained of :—

1. Pain in the frontal region of the head—124 cases.
2. Pain in the cheek—3 cases and 2 in whom slight pain in the cheek accompanied the frontal pain.
3. Ear trouble in the air—19 cases.
4. Catarrh. Only symptom, 7 cases. With other symptoms—24

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cases. In addition 3 men were found to have an active maxillary sinusitis when they came under treatment for other conditions, 2 for acute otitis media and one for conjunctivitis.

Thus there are four main symptoms which may be single or combined and which may be present in the air, on the ground or both together. Classification of the symptoms in this way gives twelve groups which are tabulated with their ultimate disposal in Table C.

Group 3 in Table C consists of flying personnel who developed a sinusitis which gave the ordinary symptoms on the ground and the majority did not fly until the sinusitis had been successfully treated. Their symptoms were not influenced by flying mainly because they did not fly while the symptoms were present or while they had an active sinusitis. But there was some sort of difficulty in all these cases otherwise they would not have been referred to the Consultants' Department. It is interesting to note that 15 out of 20 of these cases got back to full flying duty. And from this it may fairly be deduced that the ordinary case of acute sinusitis, which responds to treatment in the way we hope, can go back to full flying duty and expect his ability to fly and his comfort in the air to be unaffected by his recent sinusitis. This is an important point and should be emphasized.

It is seen from Tables B and C that the commonest symptom is pain in the frontal area. 124 men complained of this as compared with 3 men complaining only of pain in the cheek. Yet in the majority of cases the sinus infection diagnosed was maxillary sinusitis, Table D. Therefore frontal headache is caused by flying with a maxillary or an ethmoid sinusitis as well as with a frontal sinusitis. The mechanism of this is not known, but I believe that the pain arising in the antrum is felt in the cheek or upper jaw and the pain arising in the frontal sinus is felt in the frontal region. I present briefly two reasons for this belief. Firstly, when an attempt is made to wash out an antrum with a blocked ostium the pain caused by increase or decrease of pressure is referred to the cheek or teeth and not to the frontal region. Secondly, the pain in a closed empyema of the antrum is felt in the cheek or teeth. The pain of an acute maxillary sinusitis is only felt in the frontal region when pus is draining from the antrum into the middle meatus of the nose. I therefore regard the frontal pain in antral disease as being due to pus or inflammatory changes in the middle meatus of the nose affecting ventilation of the frontal sinus and not directly to pus in the antrum.

In view of the frequency of a maxillary sinusitis accompanied by frontal pain on flying we have to postulate some mechanism whereby the infection in the maxillary sinus causes a pain arising in the frontal sinus during rapid changes of atmospheric pressure. It is not difficult to guess at a possible mechanism, but I have no proofs or experimental evidence to offer and I will not burden you with my guess.

## The Effect of Sinusitis on Flying Personnel

The headache in the frontal area of which so many complained needs further elaboration. The headache caused by flying with sinusitis is characteristically frontal and not temporal or vertical. The patient often locates the pain on the floor of the frontal sinus above the inner canthus. The other and chief characteristic of the pain is that it is aggravated by changes of altitude and lessened by level flying. The pain does not usually come on, or if present, become aggravated during ascent, but most commonly it is induced and aggravated by descent. Usually the patient flies quite comfortably until descent is begun and even then nothing happens until after he has lost a few thousand feet when the pain comes on and increases rapidly in intensity if the descent is continued. When the aircraft levels out the pain gets gradually better and is rapidly relieved by re-ascent. The intensity of the pain is definitely increased by increasing the rate of descent and is much more definitely related to the rate of descent than is the allied condition, otitic barotrauma. Thus in service flying the pain is usually bad when the patient lands and it gradually disappears during the next few hours. It is not usually relieved by attempts at auto-inflation and is rarely relieved by steam inhalations or vasoconstrictors. Several patients under review have complained of pain behind the eyes or far back on the roof of the orbit. It is doubtful if this can be considered a true-sinus pain unless it is induced by changes of altitude and not by other factors in flying, e.g. duration of flight or type of aircraft or type of duty in the aircraft or by the strain induced by difficult flying conditions.

This frontal headache, as described, is characteristic of a sinus pain induced by flying, but not all patients with sinusitis and with headaches induced or aggravated by flying present this characteristic picture. With increasing experience I am coming to regard these features as being an essential part of the picture of sinus pain induced by flying. Any headache induced by flying without these features being present should not be diagnosed as being due to the sinuses even in the presence of an active sinusitis, for we know that many men can fly with an active sinusitis without producing symptoms. We also know that many men without sinusitis, or any other physical cause, suffer from headaches which are induced by flying.

Headaches present an extremely difficult problem for the service doctor responsible for flying personnel. Service flying is a most unnatural existence exposing the flier to much mental stress and mental conflict and, not surprisingly, results in psychogenic headaches in a large number of men. By contrast, many airmen with a radiological haziness or opacity in one or more of the anterior group of sinuses are able to fly operationally without producing symptoms of any sort. One is thus frequently faced with the problem of an airman with headaches and a radiological opacity of the sinuses. The problem is whether

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the headaches are caused by the condition which produces the radiological opacity or whether the headaches are independent of the sinuses. In the first case treatment of the sinuses can be expected to cure the headaches and in the second case not only will sinus treatment not benefit the patient but it will confirm him in his psychogenic headaches and make his return to flying duty much less probable. There is no doubt that many of our failures of treatment fall into this category. Incidentally this applies also to personnel other than aircrew and I am convinced that surgical treatment to the sinuses in civilian life often fails to cure the symptoms of the patient with sinusitis because the symptoms are not caused by the sinusitis.

However, in the Royal Air Force this problem has to be faced and a decision made before treatment is begun, for once treatment has started the patient is accepted as a sinus case and must be disposed of as such, as there is an appreciable advantage to the airman if the cause of his removal from flying duty is physical and not psychogenic. In fact he has been given a peg on which to hang his psychological difficulties and an escape from his problem by being taken off flying as physically unfit if his symptoms persist in spite of sinus surgery. Headache may be, therefore, the only complaint in both sinusitis and breakdown under psychological stress. In sinusitis the pain in the head is the only complaint and is also the only symptom except, perhaps, for minor nasal symptoms summed up as catarrh. The psychogenic headache, however, though the only complaint, is not the only symptom. Close questioning in these cases will reveal a number of other symptoms. Apprehension before or during flight usually precedes the onset of the headaches. The patient becomes irritable and solitary. He becomes intolerant of noise in aircraft or in the mess and particularly is he intolerant of a blaring radio in the mess. He takes a long time to go to sleep and, when asleep, he is disturbed by dreams. He smokes more than he used to and his consumption of alcohol increases with the onset of the headaches. Further enquiry usually discloses extra-service stress, domestic or financial, in these cases. As long as he is at a flying unit he usually gets headaches on the ground and in the air. These are some of the associated symptoms of the psychogenic headache. But the main distinction remains the characteristics of the headaches. The sinus pain is frontal or maxillary and it is induced or aggravated by changes in altitude, more commonly descent than ascent, and not by absolute altitude. It may persist for some hours after landing. Typically the patient with a psychogenic headache will complain that the headache gets worse the longer he is in the air and it will vary with the altitude and not with changes of altitude. For example, he will say that he can fly at 5,000 ft., but if he flies at 15,000 ft. the pain will come on after about an hour and increase in intensity until he comes to a lower altitude. Again the psychogenic

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headache will vary with the type of aircraft or some particular type of flying duty, or even with the losses sustained by the unit. Our neuro-psychiatric colleagues consider psychogenic headache to be a positive diagnosis and not a diagnosis to be made by the exclusion of all physical causes of the headaches. As a result of this enlightened attitude they are of great assistance to us in sorting out these difficult cases.

At this point it is interesting to note that of the men complaining of symptoms in the air only, 54 per cent. returned to full flying duty and of those with symptoms on the ground only, 80 per cent. returned to full flying but of those with symptoms in the air and on the ground, only 32 per cent. returned to full flying duty. This suggests, correctly I think, that we still fail to separate those patients whose symptoms are due to sinus pathology from those whose symptoms are independent of the sinus pathology which exists in the same patient. This is not entirely due to ignorance, but is partly due to our prejudice in favour of giving the patient the benefit of the doubt where reasonable doubt exists, and thus attaching a label of physical disability to his case. It is only when characteristic frontal pain accompanied by positive radiological findings and physical signs is present that the pain can certainly be ascribed to the sinusitis. With a dome-shaped shadow at the base of the antrum, no physical signs and characteristic frontal pain the patient is given the benefit of the doubt. But where the pain is more characteristic of the psychogenic headache and diffuse haziness of the antrum or the dome-shaped shadow is the only positive evidence of sinusitis I consider that the case is not one of sinus pain due to sinusitis and that no treatment should be directed towards the sinuses.

There is one other characteristic symptom which is variously described as being "hit over the forehead with a crowbar" or as being "stung in the forehead by a bee". This comes on during very rapid loss of height as in a power dive. The frontal headache persists afterwards. On examination the nose is usually clean and radiography shows an opacity in part of one of the frontal sinuses. This is due to a submucous haematoma of the frontal sinus. This condition was described by Hermann (Hermann, A., *Ztschr. f. Hals-, Nasen, und Ohrenh.*, *Ixviii*, 104, 1941) and Campbell (Campbell, P. A., *Ann. Oto. Rhin. Laryng.*, June, 1944) and McGibbon has told me of a case in which he operated and confirmed the diagnosis. I show X-ray pictures (No. 1, 2 and 3) of two patients seen at the Central Medical Establishment. Each presented a typical history, one "hit with crowbar while diving in Spitfire", the other "sudden severe frontal pain" during power dives in Spifires. There were 6 cases in this series of 156 which are probably cases of submucous haematoma of the frontal sinus. I recently operated on what I thought was a typical case and found a bony (No. 4 and 5) septum at the site of the frontal opacity, but no evidence of haematoma or inflammation. This,

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I think, was a developmental abnormality and had no connection with his frontal pain. Campbell states that a similar condition can develop in the antrum. We have not recognized any case of submucous haemato-ma of the antrum, though a case of frank haemorrhage into the antrum has been seen by Air Commodore Dickson, but he is not included in this series as he was not seen at C.M.E. This is a rare condition and in my opinion mild catarrhal sinusitis is probably a predisposing cause as there was something different in the patient when the haematoma occurred as they had usually been employed on similar duties for some time and the manœuvre which precipitated the haemorrhage was not an unusual manœuvre for them. However, it has been impossible to prove this when the subjects were seen at the Central Medical Establishment some time after the incident. They are included in this series as they had symptoms referable to the sinuses and evidence of sinus pathology when seen.

### Treatment

The treatment of these cases was both operative and non-operative. Antrum puncture and lavage is considered to be non-operative treatment. Table E shows the operations performed and the disposal of the patients after treatment was concluded. It will be seen that 46 of the 80 patients operated on returned to full flying duty and a further 15 were returned to limited flying duty, only 19 (24 per cent.) being taken off flying duty permanently, for as far as this country is concerned repatriates are permanently lost to flying duty. Non-operative treatment returned 38 to full flying duty, 10 to limited duty and 25 were made permanently unfit, 3 are still under treatment. So that on the whole the results of non-operative treatment are worse than operative treatment. This, I think, is because in many of the cases operated on there was some definite pathology which could be cured by operation. In the cases which were treated without operation many recovered with antrum puncture. This accounts for many of the successes of non-operative treatment. The failures are made up mainly of men in whom some radiological abnormality was found to justify the diagnosis of sinusitis, but the clinical signs were minimal, and as they suffered only from symptoms in the air speculatory operations were not performed as the symptoms could be cured by refraining from flying. There is no doubt that the failures in the non-operative group are largely patients in whom the sinusitis and symptoms were coincident and not cause and effect.

Surveying the operation group the conclusion reached is that operations performed for a recently infected sinus are likely to be successful in completely curing the symptoms whereas operations performed for a sinusitis which has probably been present for a long time are much less likely to cure the symptoms particularly those induced by flying. For example, there were four external frontal sinus operations. Three were

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performed for an acute frontal sinusitis leading to swelling of the eyelids, severe frontal pain and pyrexia. These three operations led to complete cure of the symptoms and these men are now on full flying duty with no recurrence of pain. The fourth external frontal sinus operation was performed for characteristic and persistent frontal pain, on flying accompanied by frontal pain on the ground, a high deviation of the septum to the same side and gross radiological opacity of the appropriate frontal sinus. Operation, with a permanent good opening into the frontal sinus, cured the headaches on the ground, but did not cure the frontal pain on descent in an aircraft and he was therefore permanently grounded. Further evidence of the success in treating recent cases of sinusitis is that of the 26 patients whose symptoms were present only on the ground 13 were subjected to operation and all 13 were returned to full flying duty. Of the 13 treated without operation 7 returned to full flying duty.

The results of treatment and the failure in many cases (34 per cent.) to cure the symptoms or even to alleviate them sufficiently to permit a return to limited flying duty emphasizes the fact that the presence of sinusitis and headaches in the same patient does not always mean that the headaches are caused by the sinusitis. This is particularly noticeable in flying personnel whose life involves constant subjection to mental stress. Careful history taking is the only safeguard we have against advising operations which fail to alleviate the symptoms and lead to disappointment and disillusionment. The nature and site of the headaches, time of onset, the duration and the factors precipitating them are all of help in deciding the etiology, also the patient's mental and physical background should be taken into consideration with any associated symptoms which can only be elicited by careful questioning.

There is exceptional opportunity in the service for routine examination of healthy adults and a surprising number of cases have been observed where radiological opacities in the sinuses are accompanied by no physical signs and are causing no symptoms and when untreated, continue to cause no symptoms. This should be borne in mind when assessing the relation of symptoms to radiological abnormalities of the sinuses.

### Conclusions

1. The presence of an active sinusitis in flying personnel may produce symptoms in the air while remaining symptom free on the ground. These symptoms may be sufficiently severe to render a member of aircrew unfit to perform his duties.
2. The symptoms of an active sinusitis may be expected to be aggravated by flying.
3. Though the symptoms produced or aggravated by flying may be sufficiently severe to render the flyer inefficient as a member of aircrew,

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there is no evidence to show that the course of the disease has been adversely affected by flying.

4. The only important complication caused by flying with sinusitis is otitic barotrauma. This only occurred in 14 of 130 men who flew with sinusitis and is not important unless the flight is above 5,000 ft.

5. There is no appreciable risk of doing damage, though the patient may get severe pain, in allowing patients with sinusitis to fly as passengers provided they can auto-inflate the middle ear without difficulty.

6. The most frequent cause of the failure of treatment of sinusitis to restore a man to flying duty is faulty diagnosis of the cause of the pain.

7. Acute sinus infection which responds normally to treatment does not cause any lasting flying disability.

8. The chief symptoms caused by flying with sinusitis are : Frontal pain, pain in the cheek, pain in the ear and deafness. Approximately 4 out of 5 cases complain only of frontal pain.

9. Patients with an active sinusitis can sometimes fly without any symptoms being produced, but this is exceptional.

TABLE A.  
DISPOSAL OF CASES OF SINUSITIS.

	Full Flying Duty.	Limited Flying Duty.	Permanently Unfit for Flying.	Repatriated.
Symptoms in the air only .. ..	37 54·3%	15 22%	12	4
68 Cases .. .. .. ..	76·3%			23·7%
Symptoms in the air and on the ground .. .. .. ..	20 32·3%	9 14·4%	18	13
60 Cases .. .. .. ..	46·7%			53·3%
Symptoms on the ground not affected by flying or having no relation to flying .. ..	20 77%	2 7·7%	2	2
26 Cases .. .. .. ..	85·7%			14·3%
Total 154	77 49%	26 17%	32	19
		66%		34%



FIG. 5.



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TABLE B.  
ANALYSIS OF SYMPTOMS.

Frontal Headache 124 Cases	(1) Brought on by flying* .. .. .. .. .. .. 51 (2) Brought on by flying and associated with nasal catarrh .. .. .. .. .. .. 14 (3) On ground only .. .. .. .. .. .. 20 (4) On ground and aggravated by flying .. .. .. 39
Pain in cheek 3 Cases	(5) Brought on by flying .. .. .. .. .. .. 2 (6) Brought on by flying and associated with nasal catarrh .. .. .. .. .. .. 1
Otitic Barotrauma (Pain in ear and deafness on flying) 19 Cases	(7) Only symptom .. .. .. .. .. .. 5 (8) Associated with frontal headache on flying .. .. .. .. .. .. 4 (9) Associated with frontal headache on the ground .. .. .. .. .. .. 1 (10) Associated with bad catarrh on the ground .. .. .. .. .. .. 9
Nasal catarrh 7 Cases	(11) No symptoms caused by flying .. .. .. .. .. .. 6 (12) Catarrh made worse by flying .. .. .. .. .. .. 1
Other symptoms	(13) Not associated with flying .. .. .. .. .. .. 3

\* Two of these cases also complained of slight pain in the cheek on flying.

TABLE C.

	Total.	Full flying duty.	Limited flying duty.	Permanently unfit for flying.	Repatriated.	Under treatment.
1. Headaches in air only ..	51	33	11	7	—	—
2. Headaches in air, catarrh on ground .. ..	14	6	1	7	—	—
3. Headaches on ground ..	20	15	2	2	1	—
4. Headaches in air and on ground .. ..	39	14	5	12	5	3
5. Pain in cheek in air ..	2	1	1	—	—	—
6. Pain in cheek in air and catarrh .. ..	1	—	—	—	1	—
7. Ear trouble in air ..	5	3	—	1	1	—
8. Ear trouble in air and headaches in air ..	4	2	1	—	1	—
9. Ear trouble in air and headaches on ground ..	1	—	—	—	1	—
10. Ear trouble in air and catarrh .. ..	9	2	4	3	—	—
11. Catarrh. No air symptoms	6	5	—	—	1	—
12. Catarrh. Much worse in air	1	1	—	—	—	—
13. Otitis media .. ..	2	2	—	—	—	—
14. Conjunctivitis .. ..	1	—	—	1	—	—
Total .. .. ..	156	84	25	33	11	3

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TABLE D.  
RELATION OF SITE OF PAIN AND SINUS AFFECTED.

Sinus affected.	Total.	Patients with frontal pain.		
		In air.	In air and on ground.	On ground only.
Maxillary sinus .. ..	63	39	14	10
Frontal sinus .. ..	28	9	13	6
Anterior group of sinuses ..	28	12	12	4
Ethmoid only .. .. ..	4	4	—	—
Doubtful .. .. ..	1	1	—	—
Total .. .. ..	124	65	39	20

Of these, two patients complained of pain in the cheek in the air as well as frontal pain. In one the maxillary sinus only was infected, and in the other the anterior group of sinuses were infected.

TABLE E.  
OPERATION RESULTS.

Nature of Operation.	Total.	Full flying duty.	Limited flying duty.	Permanently unfit flying.	Repat-riated.	Under treatment.
Intranasal Antrostomy ..	32	19	6	6	1	—
Intranasal Antrostomy & S.M.R.	5	1	1	3	—	—
S.M.R. .. .. ..	10	6	1	2	1	—
Turbinectomy .. ..	1	1	—	—	—	—
Caldwell-Luc .. .. ..	15	10	1	3	1	—
Caldwell-Luc and S.M.R. ..	2	1	1	—	—	—
Removal of nasal polypi ..	2	1	1	—	—	—
Removal of nasal polypi ; S.M.R.	1	1	—	—	—	—
Intranasal frontal operation ..	3	—	3	—	—	—
Intranasal frontal and S.M.R.	3	1	1	1	—	—
Intranasal frontal & antrostomy	1	1	—	—	—	—
External frontal operation ..	3	3	—	—	—	—
External frontal and S.M.R... ..	1	—	—	1	—	—
Bilateral radical frontal opn.	1	1	—	—	—	—
Total operative cases .. ..	80	46	15	16	3	—
Non-operative cases .. ..	76	38	10	17	8	3
Total .. .. ..	156	84	25	33	11	3

# DIVERTICULA OF THE THORACIC PORTION OF THE OESOPHAGUS WITH A CASE RECORD

By J. A. SEYMOUR-JONES (Capt., R.A.M.C.)

DIVERTICULA of the hollow viscera are of widespread distribution throughout the body. Their occurrence in the foregut has been a matter of clinical record for almost 200 years, since Ludlow in 1769 reported a case of a pharyngeal pouch, although before this date the condition had been noted at autopsy. Ludlow's patient lived for five years and death was attributed to the diverticulum. In the following 20 years several authors cited cases in the living, and suggested various therapeutic measures such as nutrient enemata, oesophageal tube feeding and the passage of bougies. No attempt, however, was made to study these diverticula or investigate their pathology until a full century had elapsed. Then in 1877 Zenker and Ziemssen published their important monograph on diseases of the oesophagus, and first classified diverticula under two main groups according to their method of production, namely pulsion and traction. Their classification has persisted substantially to the present day.

Wherever they may be situated, diverticula are developmental or pathological in origin. It is as well in considering developmental abnormalities to recall briefly the embryology of the region of the primitive pharynx. In early foetal life, at approximately the five-week stage a median elevation arises in the ventral pharyngeal wall. This elevation, termed by Frazer the hypobranchial eminence and by His the copula, receives the ventral ends of the 4th, 3rd, and later 2nd visceral arches. After the caudal portion of the hypobranchial eminence has become separated from the dorsal part of the tongue it comes into continuity with two linear ridges also situated in the ventral pharyngeal wall, the whole forming an inverted U and called by His the furcula. These ridges Frazer identified as the 6th visceral arches. The groove contained by the furcula is carried down on to the ventral wall of the foregut as the laryngo-tracheal groove and appears at the fifth week of intra-uterine existence. As the groove deepens its lips fuse to form a septum which converts the groove into a tube, the laryngo-tracheal tube, opening into the pharynx above by a slit-like aperture. The process of fusion commences at the caudal end of the groove and extends headwards, and as differentiation proceeds the cephalic part forms the

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larynx, the inside portion the trachea, while from the caudal end two lateral outgrowths arise to form right and left lung buds.

Development errors in the oesophagus are not uncommon and may lead to pouch formation. A useful classification of these anomalies has been proposed by Vogt :—

- (a) Complete absence of the oesophagus—a rarity.
- (b) Absence of the middle portion of the oesophagus, leaving blind upper and lower pouches, neither communicating with the trachea.
- (c) Fistulous communications with the trachea, these :—
  - (i) A blind lower pouch, the upper portion communicating to trachea.
  - (ii) A blind upper pouch, the lower portion communicating with the trachea. This is the common form and according to Vogt comprises 70-80 per cent. of all cases.
  - (iii) Both pouches communicate with the trachea.

The rationale of these mal-formations is obscure. That heredity plays a part cannot be doubted, the best evidence deriving from Mackenzie's account of three infants, all born with tracheo-oesophageal fistulae, of different wives by the same father. One theory holds that as the oesophagus is at one stage of its development a solid rod of cells, imperfect canalization later might cause atresia. This view does not explain the fistulae, because the solid rod stage occurs in the twenty week embryo, whereas the tracheo-oesophageal septum is fully formed in the fourth to sixth week foetus.

Others have maintained that one or both of the oesophago-tracheal septa may deviate and fuse with the dorsal wall of the foregut, causing atresia. A third view-point put forward by Rosenthal is that atresia is the result of uneven cell growth in the laryngo-tracheal septum and not due to a mechanical deviation.

In discussing the investigation of these anomalies Singleton and Light stress the danger of using barium sulphate as a radiological contrast medium, owing to the grave risk of an aspiration pneumonia. They recommend Lipiodol, which should be aspirated with all speed after the exposure has been made.

Pathological diverticula may be caused in the following ways :—

(a) By traction. Such diverticula are the result of extra-mural oesophageal inflammation and subsequent contraction of scar tissue. The commonest cause is caseation of a tracheo-bronchial lymph gland, but non-specific pericarditis and mediastinitis have been recorded as responsible agents. These pouches are most frequently found in the anterior oesophageal wall at a point immediately below the tracheal bifurcation. They tend to be small with an elliptical orifice and directed with their apex upwards rather than downwards. More commonly



FIG. I.



## Diverticula of Thoracic Portion of Oesophagus

single, multiple pouches have been recorded. They are usually symptomless, but rarely complications arise through the impaction of food or foreign bodies in their lumen and perforation has been known to occur.

(b) By pulsion. These pouches are usually found in the lower third of the gullet and may also be single or multiple. Dessecher was of the opinion that in these cases a history of cardio-spasm could always be obtained. This may be true in those instances when the whole lumen of the oesophagus becomes saccular, but Barrett disagrees with this view when the pouches are small. Uniform dilatation may certainly occur above innocent or malignant strictures, owing to an increase in the intracœsophageal pressure and Raven states that the epithelial lining may herniate through the muscular coat to form a saccular pouch in cases where spasm has been imposed on a local oesophagitis. Heacock in a collection of 87 cases, to which he added two of his own observation, stated that in one third of them a history of cardio-spasm had been elicited.

It is not unlikely, as Barrett suggests, that a certain proportion of diverticula are initially caused by extramural traction, and subsequently attain their full dimensions through the effects of an increase in intracœsophageal tension. Lee MacGregor mentions a rare type known as Leugart's pouch. A fibrous band is found passing from the left bronchus to the lateral aspect of an adjacent vertebrae and is crossed by the oesophagus which diverges slightly to the left at this point. Occasionally its wall may prolapse over this ledge, giving rise to a small diverticulum.

Vinson considered that oesophageal traction diverticula were much commoner than the better known pharyngeal pouch of Zenker, but that owing to their small size and shape symptoms referable to the oesophagus were rarely observed. He was able to collect 42 cases from the records of the Mayo Clinic, in which the sex distribution was exactly equal and the age incidence ranged from 27 to 80 years. In 13 there was definite evidence of respiratory disease, 3 having proven pulmonary tuberculosis and 8 thoracic injuries. In 18 the diverticula were situated in the middle third of the oesophagus, in the remainder in the lower third just above the cardiac opening. In 2 cases two diverticula co-existed. He was impressed by the difficulty of evaluating symptoms and associating them with the oesophageal regions. In 12 of his cases the symptoms did not suggest a diverticulum, although in 18 the diagnosis had been tentatively made. These symptoms were as protean as dysphagia, epigastric pain, vomiting, regurgitation of food, pain below the sternum, cough, fever, heartburn, nausea, haematemesis and hiccough. In most instances they were mild and no treatment was instituted.

Eight out of 18 cases had cardio-spasm, 6 were relieved by the hydrostatic bag and 4 out of 10 by passing a sound into the stomach.

In the case recounted below the diverticula were two in number and

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situated in the lower third of the oesophagus immediately above the cardiac sphincter.

CASE.—Sergente S., age 38 years, an Italian N.C.O., was captured by British troops in North Africa. After the Italian Armistice he was employed as an electrician by the British Forces. In March, 1944 he had an attack of bronchitis, with a mild pyrexia, cough, and pain across the shoulders. He was admitted to an Italian hospital and discharged to duty after 8 days. He remained well, though he still experienced pain in the shoulders until August, 1944 when he began to suffer from attacks of dyspepsia. The symptoms were rather indefinite and consisted of epigastric discomfort, sometimes amounting to pain, coming on within a few minutes of taking a meal and lasting as long as 6 hours. He suffered from eructations and meteorism but never vomited. He was admitted to another Italian hospital where tentative diagnoses of peptic ulcer or appendix dyspepsia were made. Radiological investigations were carried out and a report rendered of "oesophageal diverticula". He then left the hospital and was repatriated to Italy, where he was re-employed as Co-operator in the British Forces. His symptoms, however, persisted, and on February 2nd, 1945 he was admitted to a British Military Hospital for investigation.

O.E.—He was seen to be a well-built, healthy man, about 5 ft. 10 in. in height, weight about 160 lbs. Prematurely grey, with a moderate dorsal kyphosis. A general routine clinical examination revealed no abnormality. The vertebral column was quite mobile. From a psychiatric aspect he was well balanced and gave a perfectly clear history of his complaint. He states that he thought British Army rations did not agree with him, and that he obtained no relief from alkalies, but that when he ate Italian food with a higher vegetable (cellulose) content his symptoms of dyspepsia largely disappeared. He was rather worried about his wife, who was an invalid, and his children, who were in another district and not readily accessible. He was able to visit relatives in the locality and take meals with them in the evening.

Radiological investigations were therefore undertaken. The radiologists' report of the Barium swallow films were as follows:—

? pedunculated filling defect. ? two diverticula lower oesophagus. Stomach and duodenum normal.

It was impossible to obtain satisfactory films in the Trendelenburg position, owing to spasm of the recti abdominis muscles.

A routine blood examination and urinalysis and test meal showed no significant abnormality. The Wassermann reaction was negative. B.P. 142/76.

Œsophagoscopy was then carried out under continuous drip Pentothal anaesthesia (3·5 G Pentothal), with endotracheal oxygen.

At a distance of 16 $\frac{1}{4}$  inches (41 cms.) from the incisor teeth a small diverticulum was observed in the right postero-lateral wall of the oesophagus. A second small diverticulum was identifiable approximately 1 cm. distal to the first. The mucosal lining was perfectly normal, no bleeding or ulceration having occurred.

Post-operatively further Barium radiological examinations were made and substantially the same appearances were seen in the films.

# Diverticula of Thoracic Portion of Oesophagus

(1) *Blood Count.* Hb 90 per cent. WBC 8,800. Polys. 65. Lymphs. 27 Monos. 7. Eosino. 1.

(2) *Blood Count March 7th, 1945.* Hb 83 per cent. WBC 9,900. Polys. 46. Lymphs. 46. Monos. 7. Eosino. 1. Reds normal in size and appearance. X-ray of the thoracic spine showed a well-marked osteoarthritis.

He was therefore discharged to duty on a low protein and high carbohydrate diet, no other treatment being considered necessary.

## Comment

Most authors are agreed that oesophageal diverticula are usually unproductive of serious symptoms and that such symptoms as occur are vague and difficult to interpret. In the case I have cited there is no evidence as to the cause of the two pouches, but I feel they were of congenital rather than pathological origin. Probably the alteration in the patient's diet from Italian to British rations was responsible for some dyspepsia, which when investigated by radiography and endoscopy led to the discovery of the pouches. It seems likely that they occur more frequently than is generally credited and that a wider use of endoscopic methods would reveal their unsuspected presence. None the less, in only few cases is operative interference called for, the indications being:—

(a) In congenital atresiae and oesophago-tracheal fistulae.

(b) In complications such as impaction of foreign bodies or perforation.

(c) In large diverticula producing severe symptoms of dysphagia, or pressure on adjacent viscera. Resection and suture after thoracotomy has been successfully practised.

(d) When they co-exist with malignant strictures, when the problem is primarily that of the neoplasm.

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## CLINICAL RECORD

### A CASE OF RECURRENT TOXIC HEBETUDE FROM CHRONIC MASTOIDITIS

By W. STIRK ADAMS (Birmingham)

ON October 6th, 1931, at the age of 58 a lady of active mind and vigorous though fragile physique, widowed some years, and mother of the wife of a well-known professional colleague, was suddenly taken ill.

She felt faint at noon, and by 2 p.m. could only sit up with great difficulty. Though remaining fully conscious, and quickly appreciating the import of all questions, her responses were retarded, and her speech slurred; her memory for quite recent events was completely muddled, and a slight head tremor with lateral nodding movements, a rotatory nystagmus to the right, incoordination of arms and legs, and myoclonus in their muscles were the chief physical signs.

There were no ocular or facial palsies; optic discs were normal, Temp. 99°F., Pulse 90, and Systolic B.P. 120 mm. Hg. Her K.J.S. were brisk, and Plantar responses flexor. During the two preceding days petechial spots had appeared all over her body, with some purpuric blotches.

In her past history she had suffered from a chronic discharge from her right ear which dated from an abscess which developed during scarlet fever at the age of 4 years, 54 years previously.

The condition was regarded as a fulminating intracranial infection secondary to her chronic mastoiditis and she was admitted to hospital for treatment. To the surprise of her physicians, however, spontaneous improvement in her symptoms rapidly took place, and a fortnight after admission she was allowed to return home.

On October 25th, 1931, an exactly similar attack occurred, and she returned to hospital, where two days later a colleague carried out a right radical mastoid operation, exposing the dura of the middle and posterior fossae. No extradural abscess was found and on exploring the temporal lobe, and the cerebellum, for a possible abscess, by syringe and needle, none was encountered.

The radical mastoid operation was completed with a plastic from the meatus. Her post-operative recovery was satisfactory. Mentally she was quite clear, and speech at times was normal. - Sixteen days after operation she was able to get up, though still slightly giddy, and nystagmus persisted unchanged. On the 26th day after operation she returned home. Five days later, however, she developed an attack exactly similar to the two preceding.

Dr. Geoffrey Eden, her physician, then asked me to see her, as he was convinced her symptoms were the result of a cerebral toxæmia from a paracranial infection. I found a satisfactory radical mastoid cavity. Residual hearing was present on this side, and caloric tests showed the vestibular labyrinth was functioning.

## Clinical Record

As her mastoid had been excluded as a cause and there was no evidence of a dead labyrinth, I decided to examine her accessory nasal sinuses for a possible focus of infection.

I carried out an exploration of her accessory nasal sinuses by the Watson Williams technique under general anaesthesia. Dense sclerosis was encountered in the region of her right sphenoid, which I failed to enter. No evidence of infection was discovered in the left sphenoid nor in the ethmoids, nor in the maxillary antra. Surgical recovery was uneventful, but the procedure had no effect on the train of symptoms.

Her attacks occurred at intervals of three weeks, with little variation during succeeding months; each reaching its maximum in about 12 hours, and passing off in 36 hours. Between attacks she was normal, though with the passage of time she lost some of her natural vitality.

From time to time I examined her, and on one occasion during a free interval I noted the epithelial lining in the posterior part of her radical cavity appeared swollen as though cushioned on an oedematous bed. This at once suggested a chronic infection persisting in the mastoid; and raised the suspicion of unopened cells. An X-ray examination of the mastoid confirmed this suspicion and on April 10th, 1933, I reopened her right mastoid.

At operation the previous radical exposure was found to have been limited to the region of the mastoid antrum; and a long and tedious removal of bone was required through a densely sclerotic process to lay freely open infected tracks leading to the mastoid tip cells and the retro-facial groove.

Her post-operative recovery was good, and although she developed a further attack of typical character some six weeks after operation, from that time she remained free of cerebral symptoms until March, 1940. An attack then occurred which was found to be associated with a recurrence of infection in the radical cavity. This responded rapidly to treatment and the attack rapidly subsided. Another period of good health was enjoyed for nearly four years.

She had married again in 1937, and in addition to her home duties she was an active member of the Civil Defence Service in the present war.

Her fatal illness in 1944 was initiated by an influenzal attack from which she failed to recover and becoming gradually weaker, though mentally unaffected, she died with symptoms regarded as due to a gastric neoplasm.

### Commentary

There appears to be no question that her cerebral attacks were due to an involvement of the basal ganglia and entirely on the motor side, as no sensory disturbance ever appeared apart from a sense of weakness. Her rapid spontaneous recovery from each, and their short duration, and their ultimate complete abolition, shows their origin to have been a temporary toxæmia involving a large part of the mid-brain on both sides, though the amnesia for recent events during an attack suggests some cortical involvement. The possible routes by which the toxæmia originating in the mastoid reached the mid-brain, are:—

- (a) By blood stream.
- (b) By perivascular lymph channels.
- (c) By perineurial channels.

## W. Stirk Adams

The periodicity of the attacks suggests that a head of pressure of tension had to be built up in the mastoid tissues before the basal ganglia were affected, and on release of this pressure the full syndrome rapidly developed and as rapidly subsided.

(a) It will be noted that the first attack was preceded by subcutaneous and cutaneous petechiae. This suggests a blood stream spread, and although petechiae were not observed in later attacks it is possible that the first attack sensitized a vulnerable region of the basal ganglia.

(b) The perivascular lymph channels concerned are those around the carotid artery. There seems no evidence to show that spread occurred by these.

(c) The direct perineural channels are those around the VIIth and VIIIth nerves—if we except those nerves passing through the dura over the petrous tip.

Features suggesting an VIIIth nerve passage are the appearance of nystagmus to the right in each attack, and vertigo, and from these symptoms I conclude the passage of the toxin to the brain stem took place in her attacks through this channel, though in the first attack a bloodstream passage also occurred.

SOCIETIES' PROCEEDINGS  
ROYAL SOCIETY OF MEDICINE—SECTION OF  
OTOLOGY

December 1st, 1944

*President*—L. GRAHAM BROWN, F.R.C.S.

**Discussion on the Treatment of Endocranial Complications of  
Otitic Origin**

By E. D. D. DAVIS

*A brief review of the treatment of abscess of the temporo-sphenoidal lobe of the brain arising from the ear.*—By reviewing the treatment of a temporo-sphenoidal abscess I hope to demonstrate that this abscess should be approached and drained from the mastoid area. If drainage fails to achieve a satisfactory result in a very few chronic encapsulated abscesses then enucleation may become necessary.

The drawings of three specimens are shown to illustrate the pathology of a brain abscess. The first two are frontal lobe abscesses because they are the best specimens I could find in the London Pathological Museums.

The first drawing (Fig. 1) is a large abscess due to a sharp slate pencil which had penetrated the roof of the anterior cells in the lateral mass of the ethmoid. The point of the pencil projected into the anterior fossa of the skull for 2 cm. The patient was a boy of 17 who was comatose when admitted to hospital and in consequence it was not known when the slate pencil was pushed into the nose. The boy fell on the pavement on the way home from school, he was unconscious for a few minutes and his neurological symptoms commenced from that day five years before he was admitted to hospital comatose; hence it is probable that the abscess is of about five years' duration. The dura mater and arachnoid in relation to the slate pencil were thickened, opaque and adherent to the brain but there was no subdural or extradural abscess. The abscess cavity measures 4·5 by 5 cm. It is irregular in shape and partly enclosed by a fibrous wall or so-called capsule surrounded by cedematous brain substance. Toward the outer side a recent extension of the pathological process has occurred where a considerable amount of brain substance is seen in various stages of necrosis. In this position a loculus is forming and it is found frequently that a temporo-sphenoidal abscess extends in this way in its deepest aspect towards the descending horn of the lateral ventricle. The formation of a capsule appears to depend on the resistance of the patient and on the virulence of the infecting bacteria. The abscess is more likely to be walled off when the infection is caused by the *Bacillus proteus*, *Bacillus coli* or *staphylococci* than by the virulent streptococcus or pneumococcus. An

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encapsulated abscess is more common in the frontal lobe than in the temporo-sphenoidal. More frequently a foreign body such as a fragment of bone or a missile lodged in the brain is walled off and may cause an abscess some time later. The pulsation of the brain tends to extrude the encapsulated abscess particularly if the capsule is uncovered by removing a cap of the adjacent brain tissue from its surface. A few but not all chronic abscesses may become encapsulated and it is stated that the capsule may be firm enough to permit enucleation in from eight to twelve weeks. During this period the patient may succumb to meningitis, rupture of the abscess into the ventricle or from oedema and encephalitis, the usual termination of a fatal brain abscess. Moreover multiple abscesses, deep loculi and recent extensions make enucleation impractical and not without risk. The specimen shows a marked enlargement of the left cerebral hemisphere as a result of oedema. The anterior horn of the lateral ventricle is obliterated and the basal nuclei are distorted by compression. This patient died of oedema of the brain and encephalitis with Cheyne-Stokes' breathing. The second specimen, not illustrated, shows multiple abscesses arising from chronic suppuration of the frontal sinus and the damage done by a drainage tube introduced into the brain (see colour plate, *Proc. roy. Soc. Med.*, 1934, xxvii, 1,286). It emphasizes the necessity of placing the drainage tube accurately into the cavity of the abscess and of anchoring the tube by two stitches to the deep fascia reinforced by a firm and suitable dressing. As a house surgeon I assisted my chief, a general surgeon who at one time was assistant to Macewen, at this operation and there is no doubt that the large drainage tube was introduced into the cavity of the abscess and anchored by a stitch. It is presumed that the pulsation of the brain displaced the tube. The pulsation of the frontal lobe is always more marked than that of the temporo-sphenoidal. This patient died of cortical meningitis which was present before the drainage operation was performed.

Fig. 2 indicates the commonest site of a temporo-sphenoidal abscess of otitic origin. It is immediately above and behind the roof of the mastoid antrum with a stalk approaching the surface. It is probable that this abscess would have been missed by an exploratory burr hole or even by an osteoplastic flap which is usually made in the temporal fossa above and in front of the ear.

Fig. 3 illustrates the approach to a temporo-sphenoidal abscess through the mastoid process.

The mastoid operation is done without the mallet by using a skull gouge with the hand and a nibbling forceps. When a diagnosis of an abscess has been made or suspected, the dura is thoroughly exposed by removing the roof of the mastoid antrum and tympanum, then a burr hole is made in the squama of the temporal bone. The bony aperture is enlarged in all directions by nibbling forceps and there is no limitation to the extent of the area of dura exposed. The wound and the area are thoroughly cleansed by ether and a 1 : 1,000 flavine solution. Clean towels, clean gloves and instruments are now used before the dura is opened. The mastoid wound can be cleansed just as efficiently as the skin of the scalp over the temporal area where the neurosurgeon approaches the abscess away from the ear. This point is proved by the fact that the temporo-sphenoidal lobe has been explored on many occasions without any sepsis or harmful results. The exposed dura is isolated



FIG. 1

Large abscess in the left frontal lobe of the brain, arising from a foreign body in the nose (Charing Cross Hospital Museum), see also colour plate *Proc. roy. Soc. Med.*, 1934, xxvii, facing p. 1,288.



FIG. 2

Brain in section, showing space left by encysted abscess in temporo-sphenoidal lobe.  
(Copied from William MacEwen, *Pyogenic Infective Diseases of the Brain and Spinal Cord*,  
1893, p. 94, Glasgow.)

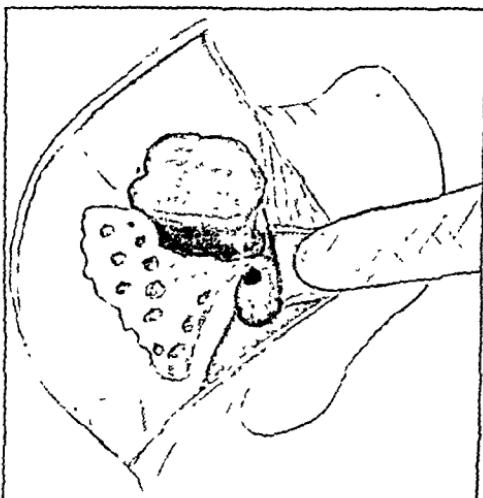


FIG. 3

Second stage of the operation in which the two openings in the skull are converted into one.  
(After Hunter Tod. Burghard's *System of Operative Surgery*, 1914, p. 309, London.)

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and its blood-vessels compressed by packing sterile gauze between the bone and the underlying dura. It is desirable to follow the track of infection from the mastoid to the brain. Therefore a small crucial incision is made in the dura using a dura mater hook in the area where the dura is thickened, covered by granulation tissue or by an extradural abscess. If the dura is normal in appearance the incision is made in the area covered by the roof of the mastoid antrum. If an abscess is present, in my experience pus escapes with the first thrust of a large needle or sinus forceps. Care should be taken not to lose the abscess and the needle is left in situ until the largest size aural speculum or an encephaloscope is slipped over the needle into the abscess cavity. Pus and debris are removed by gentle suction. If irrigation is employed it must be gentle and Ringer's solution or blood plasma should be used through the speculum. Weed and Wegeforth (1919) of the Rockefeller Institute injected the subarachnoid space of cats with antiseptics and found that chloramine, flavine and mercurochrome caused intense reaction and convulsions. Isotonic saline alone caused toxic and convulsive effects but Ringer's solution is tolerated well. Two small rubber drainage tubes stitched together are inserted into the abscess cavity through the encephaloscope. The tubes must be firmly anchored by stitches and by a reinforced firm dressing of rolls of gauze built up round the tubes to hold them in position. Various types of tubes and methods of drainage have been advocated. Packing the abscess cavity with gauze does more harm than good and should be avoided. Lemaitre's method of introducing the smallest drainage tube followed at frequent intervals by larger and larger tubes is unsatisfactory. If drainage tubes could be avoided results might be better. The dressing is untouched for six days and at this, the first dressing, preferably done in the operating theatre, the drainage tubes are removed and if there is no escape of pus the wound is allowed to close even at the risk of having to open the abscess again.

The advantages of approaching the abscess from the mastoid area as described are: (1) The source of infection can be eliminated. Extradural abscess and lateral sinus thrombosis, when present, are dealt with. Moreover the condition of the dura found at this operation will either confirm or correct the diagnosis. In some cases the important early diagnosis cannot be made without exploration. (2) The track of infection is followed where the spread of infection in the subarachnoid space is prevented by adhesions. Two cases seen by me in which an osteoplastic flap was made in the temporal region died of meningitis. (3) The lowest point of the abscess and where it is nearest to the surface is drained. (4) The area of operation can be sterilized as well as any other part of the skull.

Treatment by aspiration without any form of drainage between the tappings has been condemned by Cairns (1934). The abscess cavity fills remarkably quickly, especially when there is any oedema of the brain. Aspiration of an abscess in other parts of the body is not a satisfactory procedure.

Enucleation of the abscess is possible only when the abscess is completely walled off by fibrous tissue. In a few cases encapsulation takes eight to twelve weeks during which time the catastrophe of meningitis, rupture into the ventricle or oedema of the brain may occur. Loculation and particularly multiple abscesses make enucleation difficult. When the neurosurgeon found

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enucleation difficult and unsafe he has resorted to marsupialization. There is no evidence to show that epilepsy is more common in abscess which has been drained than that subjected to enucleation. If neurological signs and symptoms persist after drainage or if there is a permanent sinus then enucleation is probably desirable.

Marsupialization is done on rare occasions as an expedient when enucleation is unsafe or impracticable. It has always been an unsatisfactory operation for cysts in other parts of the body when they could not be dissected out.

The results of various methods of operation are difficult to express in figures. The large majority of brain abscesses are not seen until the patient is drowsy, comatose or in the terminal stage and are complicated.

The *Proceedings* of the Otological Section records a large number of successful cases treated by drainage only. At one meeting in 1927 18 successful cases were recorded and whenever the subject of brain abscess has been discussed a number of successful cases are shown.

*Results of operation.*—Macewen, 80 per cent. survived. Neumann, 47 per cent. uncomplicated cases survived; no organisms in C.S.F. Fraser, J. S. (1930), 17; 6 cases survived, 33 per cent. approx.; 6 meningitis before operation. Davis, 28: 4 uncomplicated cases survived. 24 post-mortem complicated cases.—11 meningitis before operation; 7 ruptured into the ventricle; 4 oedema of the brain; 2 multiple abscesses.

Northfield's (1942) analysis of 24 cases of brain abscess: 9 cases drained, 2 survived—cause of death not stated; 15 cases not drained, 10 survived = 8 enucleated, 2 aspirated. The 7 drained cases which were fatal may have had meningitis or some terminal complication before being drained. It is assumed that the 8 successful cases of enucleation were encapsulated and therefore were more favourable than acute cases.

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### F. W. WATKYN-THOMAS

*Labyrinth and petrous infections.*—Although these are not intracranial infections themselves they are so frequently a cause of such infections that it is fitting to consider them here. Under modern surgical conditions neither of these complications is often seen.

For practical purposes the problem of the infected labyrinth is a problem of meningitis. It is remarkable how seldom labyrinthine infections cause cerebellar abscess. This statement is upheld by the figures of Zange and the statistics of the Edinburgh Royal Infirmary. Lateral sinus thrombosis as a result of labyrinth infection occurs as a curiosity. (I have only seen two.)

Extension from the labyrinth may be through the internal auditory meatus (usually), through the bone (sometimes), along or through the aqueduct of the endolymph (rarely), and through the aqueduct of the perilymph (perhaps).

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The treatment of labyrinthine suppuration is entirely conditioned by our view as how best to avoid such intracranial invasion.

If the labyrinth is alive, it is most unlikely that it is infected. If therefore we find a fistula—or, more accurately, an erosion of the labyrinth wall—with an active labyrinth, especially if the so-called fistula sign is present, that labyrinth should be left severely alone. The proper treatment is the adequate mastoid operation and rigid non-intervention as far as the labyrinth is concerned.

If the labyrinth is so very dead that it is a sequestrum, of course it has to come out.

Last, if the labyrinth is dead and the patient already has meningitis the general opinion is that the labyrinth is a probable—or at any rate a possible—focus, and should be drained accordingly. I am not referring here to trans-labyrinthine drainage of the cisterna pontis ; that is quite a different problem.

The principal difference of opinion is what to do when the labyrinth has been killed in the course of a suppuration and the patient has not yet got meningitis. Two conditions are recognized : (1) In the course of a middle-ear suppuration the labyrinth is destroyed by infection, with all the characteristics of a "labyrinth storm". (2) The patient has a suppurating ear, totally deaf, and dead to caloric tests. Sometimes he can remember severe vertigo, perhaps diagnosed as "gastric influence", somewhere in the remote past. Sometimes he cannot even remember that. The first condition is "manifest labyrinthitis"; the second "latent". In manifest labyrinthitis without meningitis we may safely assume that, as the labyrinth has been destroyed by an aural infection it is itself infected, and so is a danger to the meninges. According to one view, once the labyrinth has been so killed it is a potential danger and should be drained forthwith. Granted that we cannot be certain that it is a suppurative rather than a serous labyrinthitis, is unusual for a serous labyrinthitis to show complete loss of caloric response and total deafness; if it should, it is highly unlikely that any useful hearing will survive. The other view is that by early operation we may precipitate the very disaster which we wish to avoid, as well as destroy a labyrinth still capable of recovery. Therefore, do not drain the labyrinth until there is definite evidence of meningeal irritation, e.g. a rise, however slight, in the cerebrospinal fluid cell count.

My personal experience, from 1920 to about 1940, was that of all cases of suppurative labyrinthitis which came into my hands, *before any meningeal signs could be detected*, I lost only three—one, an anaesthetic fatality due to unsuspected myocardial degeneration, one by a spreading necrosis of neighbouring bone (the only case of the kind I have ever seen) and one where I persuaded myself that it would be safer to wait a few days. I was wrong, that patient died of meningitis—I do not say it was cause and effect, I hope it was not, but that was only one in the series. Now, with sulphonamides available, if meningitis should appear there is a good weapon at hand to deal with it, because the bony labyrinth is the only bony cavity in the body where sulphonamides do not act at a great disadvantage. We know that they freely enter the cerebrospinal fluid, and we know that the perilymph is in continuity with that fluid, therefore we can reasonably hope to destroy the organisms in the labyrinth by chemotherapy. At present I feel that the right procedure

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when labyrinthitis appears in the course of a chronic, a recurrent, or a subacute suppuration, *provided always that there are no signs of meningeal irritation as proved by lumbar puncture*, is to load the patient with sulphonamides and, when all is quiet, to do the radical operation and to complete it by opening the labyrinth, just as one opens up any other cell system in an infected area. You may have noticed that I have excluded acute suppuration. I do not believe that the acute fulminant condition in which middle ear, labyrinth and meninges are invaded almost simultaneously is primarily an ear condition at all; I think it is a blood invasion and should be treated as such. Here the aural tract is the victim, not the focus, and opening and draining it will be quite useless. For drainage of the labyrinth I have nearly always done the "double vestibulotomy" which is safe and simple. I have done the Neumann operation, but I do not find it either safe or simple. In the actual technique of the operation I think it is most important to have really sharp chisels and gouges. I have not yet had the good fortune to use an operating microscope but I have found v. Eicken's magnifying loupe useful, but cumbersome. The danger to the facial nerve is—it seems to me—usually at the postero-inferior corner when one is working on the recess of the round window. Injury to the columella should be avoided, as the area is flooded with cerebrospinal fluid. I have seen this happen once or twice, but it has never done the least harm to the patient—all the same it is an accident to be avoided.

In latent labyrinthitis the operative findings dictate the procedure on the labyrinth. If the whole wall is covered by scar tissue, leave it alone; if there is a fistula into the dead labyrinth, enlarge it for drainage; if the labyrinth has sequestrated, take it out.

In the last two years I have not used translabyrinthine drainage for meningitis of labyrinthine origin, because I think that the continual escape of cerebrospinal fluid makes it more difficult to maintain the requisite high concentration of sulphonamide. That does not alter my opinion that, in its day, it was the greatest advance in the surgery of the condition.

By petrous invasion I mean any extension of disease into the body of the petrous; I most emphatically do not limit it to invasion of the apex, which I think is uncommon. About 35 per cent. of adult petrous bones are fully pneumatized, and in most of them some marrow persists. But, whether pneumatized or not there is a hard shell to the bone, with an excellent blood supply, and sequestration or perforation into the cranial cavity is rare. Also, the more complete the pneumatization the more complete the obliteration of the vessels passing from dura to bone and the less the risk of spread by these tracks; on the other hand, in the non-pneumatized bone the marrow is capable of stout resistance. For these reasons a petrous infection can usually be treated with deliberation.

A considerable majority of petrous invasions clear up entirely with an adequate mastoid operation and careful follow-up of any deep cell tracts—especially the group of cells in the petrous angle. I have seldom seen the sublabyrinthine cells. I think the rarity of the condition is a testimony to the care with which we do our acute mastoids. Of course there are cases in which the dangerous cells are so shut off by bone that they are absolutely undetectable at a first operation; these are the cases where petrositis develops

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some days or weeks after a mastoidectomy. In such cases the onset is seldom dramatic, an increase of discharge, a recurrence of pyrexia, sometimes—by no means always—retro-orbital pain, are the usual signs. Odd little disturbances of the labyrinth are not uncommon. Occasionally there is just the suspicion of a facial weakness. I do not think that in these cases operation is indicated immediately; it may not be indicated at all. Radiographs of the petrous pyramids should be taken; the optic discs should be watched most carefully; at the slightest suspicion a lumbar puncture should be done—and on no account whatever should we yield to temptation and mask the signs by sulphonamides. If there is any evidence of meningeal irritation, operation must be done forthwith; otherwise, unless pain and headache increase, or the pyrexia continues I am inclined to wait. The longer one can wait the more likely one is to find a track of carious bone and infected cells to follow. I do not think that a VI<sup>th</sup> nerve palsy is necessarily a proof of apical invasion, but whenever I have seen this sign in a case of petrositis I have always found other indications such as increasing pain, for operation. As to the method of operation I have always said that we are not engaged on the anatomical exercise of finding the apex, we are doing the surgical routine of hunting the pus, and our object is to protect the meninges. For this reason I have never done the Almour-Kopetsky operation. Although this is a most ingenious route to drain an abscess of the apex, it would not afford adequate drainage for the even more dangerous extradural abscess. The Ramadier operation has the same disadvantage, and as well seems to me unnecessarily dangerous. I have either followed up any available track, or where I could find none, have done the Voss-Ruttin-Eagleton method of unlocking the petrous. I have had no personal experience of approach by the endaural method, nor have I ever succeeded in finding a track through the arch of the superior canal, which Paul Frenckner has described. On three occasions I have seen a forward extension, probably through the zygomatic cells. On a previous occasion I have mentioned invasion of the superior petrosal sinus and spread to the lateral, but I have not seen such a case since these were reported. I have never myself seen an extension into the pharynx, but there certainly are such things. The possibility of approach to the petrous by a nasopharyngeal route has been suggested by Russell Burke, but as far as I know it has only been worked out on the cadaver.

One thing I wish to emphasize most strongly, that in petrositis uncomplicated by meningitis, sulphonamide treatment is not only absolutely useless, it is abominably dangerous. It is useless because the drug cannot reach the organisms, it is dangerous because it masks the symptoms and because it may, by useless over-dosage make it impossible to give the heavy doses which may be needed later if meningitis should develop.

In conclusion, may I express my deep gratitude to my colleagues who have so kindly let me see so many of these cases.

Mr. TERENCE CAWTHORNE : Meningitis was formerly the commonest cause of death in ear, nose and throat diseases. Courville of Los Angeles, in an analysis of 15,000 post-mortems, found 337 cases of septic meningitis, that is to say, meningitis due to organisms other than tubercle bacillus and meningococcus; of these 175 were otogenic. Whilst the mortality rate of meningitis

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has been dramatically reduced since the introduction of the sulphonamides it may still be the commonest cause of death.

The basis of any study of otogenic meningitis should be a consideration of the pathways by which infection may spread from the ear to the meninges, because an appreciation of these methods of spread is the key to the whole situation from the surgical point of view.

It will be convenient to consider the spread of infection from the ear to the meninges under three main headings : (a) preformed spaces ; (b) vascular channels ; and (c) direct spread through diseased bone.

*Preformed spaces.*—These can be preformed by Nature, by injury or by operation. There are many natural spaces in the temporal bone through which infection can travel, and the petro-squamosal suture when patent and the various labyrinthine channels deserve particular mention. Injury to the skull may open up a channel between the subarachnoid space and the outside *via* the ear through which infection can enter if proper precautions are not taken.

Mastoid cavities, particularly if the dura has been exposed, can sometimes be a way by which infection spreads, particularly if the dura has been roughly handled. I remember a case in which I did an extensive operation of the Neumann type for streptococcal meningitis secondary to ear disease. About a year later this patient developed a severe upper respiratory infection, and within twelve hours she was delirious. The cerebrospinal fluid was found to be teeming with pneumococci and the infection had clearly rushed through the upper respiratory tract to the mastoid cavity with its widely exposed dura. She recovered from this second infection.

A characteristic feature of this spread by preformed spaces is that the meningitis appears within a matter of hours.

*Vascular channels.*—The second group in which infection may spread from the infected middle-ear cleft to the meninges consists of those in whom the spread is by vascular channels. I do not necessarily mean the lateral sinus or any of the large blood-vessels, but would include the small veins. There are many intimate connexions between the venous drainage of the temporal bone and the meninges, and spread in this way probably accounts for those cases of meningitis which occur within a few days of the original otitis media.

*Bone destruction.*—We are all familiar with the patient with an otitis media who develops meningitis, either before or after a mastoid operation, perhaps two or three or more weeks after the otitis media. This third group, of course, consists of those to which Mr. Watkyn-Thomas has just referred. I do not think as a rule they occur within less than two weeks from the primary infection.

Then there are the cases of long-standing otitis media which give rise to meningitis. In a way these belong to the group of cases arising from preformed spaces, because the disease may have been slowly eroding the bony boundaries of the middle-ear cleft for years, resulting in an exposed dura and the patient at the mercy of any upper respiratory infection.

Thus meningitis appearing within *hours* of the primary aural infection is likely to have travelled by preformed spaces ; within *days* by vascular channels ; and within *weeks* or longer by bone destruction.

*Nomenclature.*—Such tangled verbiage as “sympathetic meningitis”,

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"meningismus", "ménингite de voisinage" and "meningeal reaction" are used to indicate what are all part of one disease, namely meningitis.

I think, therefore, that it is better to call all these cases meningitis and then, when the cerebrospinal fluid has been examined, the qualifying adjective can be added—"serous" if there is only an increase in pressure; "cellular" if there are cells, and if in addition to an increase of cells there are bacteria, it can be called a "bacterial meningitis", at the same time naming the bacterium.

I have mentioned pressure, cells and bacteria only because these are the three essential features about which information is sought when the cerebro-spinal fluid is first examined. At that time or later additional information may be desired such as chlorides, sugar, protein and sulphonamide content.

Certain types of meningitis, especially if they occur following long-standing suppurative otitis media, where the labyrinth has been invaded, show a fairly high proportion of lymphocytes in the fluid, and it may well be that the number of lymphocytes furnishes some idea of how long the infective process has been going on.

*Treatment.*—Before anything else is done the patient with meningitis requires chemotherapy. But there are certain cases which require surgery in addition, namely, the third group of which I have spoken, in which there is bone destruction. I think that only an otologist can decide which cases require surgery and to overlook such cases is to invite a relapse, possibly fatal. It is not always easy, when a patient has a discharging ear and meningitis, to decide whether or not there should be an operation. An otologist is in the best position to decide this, particularly if he can think in terms of the type of infection and the way it has spread. In fulminating cases the spread to the subarachnoid space is rather like the spread of fog into a house, underneath the door and through any crevice, and to undertake extensive mastoid surgery will not hinder the spread but will jeopardize the patient's chance of survival. The same applies to the cases of vascular spread and I feel that early mastoid surgery should not be embarked upon in any case of meningitis following within a few hours or days of an otitis media.

But in the third type of case, where there is disease of some weeks' standing, mastoid surgery with removal of diseased bone is required, and the only question there is *WHEN*. These cases are on the whole better left for a day or two—it is difficult to lay down any hard and fast rule. I now think that it is best to start a course of one of the sulphonamides before operating. My experience with sulphadiazine is small, but from what I have read I am led to believe that it is probably the best of the sulphonamides to use. Nor have I any personal experience of penicillin in meningitis. The one drawback to penicillin is that it has to be given intracisternally or intrathecally.

As to the introduction of various sera into the thecal space I have always felt very strongly that the less one introduces into the theca or cisterna the better, for with but few exceptions—and I believe penicillin is one—intrathecal medication does more harm by irritation than good by combating infection.

Mr. F. McGUCKIN: My interest in brain abscess was aroused in dramatic fashion some fifteen years ago, when I watched a lateral ventricle rupture

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through a temporal lobe abscess, the peripheral wall of which had just been incised. This was the first of three such cases published in the *Lancet* in 1936. All three recovered. By 1935, 100 cases of abscess had been summarized, 39 of which were personally surveyed in part or in whole. Though interest remained, enthusiasm was curbed, first by the ups and downs of good and bad run of cases, and secondly by the unfortunate sequelae, fits for example, in some of the recovering temporal cases.

In the series, the causes of death fell roughly into two groups : those from diffuse cerebrospinal infection usually by ventricular erosion, and those resulting from pure pressure exerted finally on the medulla. Correct timing of intervention, if this were possible, was clearly the preventive treatment of the first accident. The pressure factor suggested the cardinal importance not merely of timing but of so limiting intervention as to avoid increase in tension from traumatic oedema.

The study of the morbid anatomy of brain abscess is important. The part played by the Virchow-Robin space in the transmission of temporal abscess is clear enough ; though I think not enough attention has been given to the superior petrosal sinus or to thrombosis of veins included in a localized patch of leptomeningitis.

Up to 1935 I had not personally surveyed a single case of cerebellar abscess, alive or dead, in which a labyrinthine transmission was proved to my satisfaction, and in the 100 cases already mentioned there were but 2 out of 44 cerebellar abscesses in which a labyrinthine origin was clearly demonstrated, one *via* the posterior semicircular canal and one *via* a saccus empyema. In my experience lateral sinus thrombosis has accounted for nearly half the cases, and it was responsible for both my cases of non-suppurative cerebellitis. The mechanism is that of retrograde thrombosis of communicating veins. On the score of the mechanics of internal hydrocephalus, which may be extreme in temporal lesions, tribute must be paid to the brilliant work of Jefferson and Rowbotham on tentorial pressure cone due to herniation of the uncinate process of the temporal lobe. This work, for me, ended ten years of confusion about the matter.

I believe there are three features which suggest that the otologist may justly retain some place in the conduct of this disease. First, the mastoid approach sometimes locates an abscess with very great accuracy and often with much greater accuracy than the neurosurgical approach. Moreover there is a fair chance of crossing an adherent subarachnoid space. Secondly, the otologist may with very little trauma and minimal reactionary oedema, tide over the patient, for subsequent drainage or excision, by the simple process of tapping and re-tapping. Thirdly, in a notable minority of cases the neuroglial agglomeration and fibroblastic proliferation will have produced an encapsulation sufficient for minimal surgery and at the same time insufficient mural rigidity to prevent obliteration of the cavity on emptying. Such cases may recover on simple tapping.

There are two cardinal principles in the conduct of the acute phase of brain abscess : (1) Interference should be properly timed ; and (2) it should be as little as may be and as gentle as possible.

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In labyrinthine invasions, I find chronic otitis media and especially cholesteatomatous lesions a frequent cause of erosion *via* the lateral and superior canals and less commonly through the promonotory. In many cases I have sucked cholesteatoma from the labyrinth and in not a few found that organ virtually absent, though the facial nerve has usually held its own throughout. I am not convinced that this route, in such chronic and resisted lesions of this kind, accounts for more than a small proportion of leptomeningitic cases falling within my experience and it has been my custom simply to deal with the labyrinth secundum artem during the course of operation. Acute purulent labyrinthitis has been a rare disease among my cases, perhaps because conservatism showed so many invasions, apparently catastrophic, to recover some function quite quickly. Acute invasions, however, are clearly to be feared in relation to meningitis because of the preformed paths but it is pertinent to mention that these paths cut both ways, e.g., the frequency of cochlear destruction in meningococcal invasions. I suggest that it is quite possible for an otogenic meningitis to invade a labyrinth *via* the nerve sheaths, and that scrutiny of most careful kind is necessary before accepting a post-mortem labyrinthitis as necessarily indicating the route of invasion.

If all acute ears were X-rayed, petrositis would be established with a frequency quite out of proportion to its real significance. This is but another example of the need to interpret X-ray shadows by the light of clinical experience. This entity can be recognized quite frequently and indeed one's clinical estimate may often be supported by serial X-rays but I do hold that the important partner is the clinical estimate. Potentially dangerous though the condition may be, it is a fact that a relatively small proportion of cases develop real complications and I believe that the mortality attending unrestrained surgery is a greater danger. The majority of cases will react to a careful mastoidectomy, with an odd case here and there calling for a little investigation of the deep track.

Mr. ERIC WATSON-WILLIAMS said that he was amazed to hear of an abscess being tapped three or four times. His own practice had been, when he had found an abscess, to put in the smallest drain he could. He had had a certain number of recoveries by following that method.

He could not see the object, if there was a dead ear, of leaving the suppuration in the labyrinth undrained. The sulphonamides would do a great deal of good, but not too much must be expected of them. One point of importance to the patient was that if the ampulla were carefully curetted he woke up from the anaesthetic completely recovered from the vertigo. He had had one case in the previous week, and what impressed the patient who had had five days of acute labyrinthitis was that he woke up without any sense of giddiness.

In meningitis, again, the sulphonamides did much, but there were cases in which the meningitis recurred. It was very important to drain—he did not mean through the internal auditory meatus, for that was only very rarely indicated—that is to say, to get proper drainage of the infected focus. Before the days of sulphanilamide he had quite an encouraging number of recoveries simply from early operation, with the giving of intravenous silver in large doses.

Mr. J. N. DEACON referred to two cases of acute mastoiditis, each with

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meningitis which had developed in spite of heavy dosage of sulphonamide given prior to admission. In each case organisms were found in the C.S.F. and pus in the mastoid. Penicillin 10,000 units in 1 per cent. glucose was given intrathecally at the time of the mastoid operation and continued daily. The temperature fell to normal in forty-eight hours, in one case after two injections and in the other after three. They had now had six and seven injections respectively, and were doing remarkably well. He was considering now taking them off penicillin.

Mr. DONALD WATSON said that he had started the study of labyrinthitis with J. S. Fraser twenty-four years ago and, with his help, learned a great deal about it. After two years there he went down to Bradford and carried out the teaching which he had learned in Edinburgh, but in the course of four years in Bradford he had three deaths from meningitis following labyrinthitis. On the other hand his colleague had no deaths from meningitis following labyrinthitis. He discovered that the one respect in which his colleague's practice differed from his own was that his colleague did not test any labyrinth. He thereupon followed the same course in those cases where pus was present, and now for eighteen years he had not tested cases with labyrinthine symptoms when infected, and he had had only one death from meningitis which had been preceded by labyrinthitis. That one case was of the fulminating type mentioned by Mr. Watkyn-Thomas in which the mastoid labyrinth and the meninges were all infected, in a child of 6. This had been a negative kind of research but he would make a plea that any case of labyrinthitis should be treated very conservatively and rested, and then, when the symptoms had disappeared, one could use one's surgical judgment to do what was thought to be required.

Major E. P. FOWLER, Jr., U.S.A.M.C., said that in an analysis of anatomical specimens the commonest site of invasion of the meninges was through the wall of the posterior fossa. The invasion was directly through the back of the petrous bone and, most commonly, through a cell which was very close to the anterior way of the internal auditory meatus.

He thought that surgery was necessary with meningitis, though he agreed that it was not important to carry it out as quickly as they used to do. Infection in the temporal bone should be drained. However, if one operated on a mastoid too soon it was likely to spread. On the other hand, the making of a small hole into the mastoid would relieve the pain and give adequate drainage when myringotomy was inadequate. It was a very simple procedure to increase the drainage in this way and not dangerous. With sulphonamide therapy it was sometimes unnecessary to do a complete mastoidectomy at a later date but this was not the rule.

Colonel NORTON CANFIELD, U.S.A.M.C., said that for several years past at his hospital they had worked on their brain abscess cases in conjunction with the neurosurgeons. The location for the drainage had been a source of considerable discussion as to whether it should be through the mastoid or through a posterior incision entirely outside the field of mastoid operation. If the brain abscess were given time enough to become encapsulated the results seemed to be better with the draining of the abscess by a second incision over the abscess site, not through the mastoid wound. He had no figures at the

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present time to bear that out, but it seemed that the handling of the dura and the brain substance itself, with the wide drainage of the abscess which could be done in that manner—and could be done by the otologist if he was able to handle brain tissue—gave better results in these cases.

He wanted to emphasize again the point concerning the testing of the labyrinth by stimulation in the presence of infection. He had not carried out that procedure because of the possibility of increasing the intratemporal bone pressure. He wondered whether Mr. Watkyn-Thomas had found cases in which it had been followed by a severe reaction.

Another way of cold caloric stimulation of the labyrinth in the presence of pus was to use air and it would then be possible to decrease the temperature without the disadvantage of introducing cold water.

Mr. Cawthorne's presentation had opened up a good many points which might be discussed. He was of opinion that the fulminating cases which occurred in certain patients belonged to a group in which the middle ear and temporal bones constituted only a portion of the entire picture, and it was not necessarily the fact that the meningitis made its appearance in the meninges by means of or through the ear. To give such cases a sulphonamide drug was one of the greatest protective measures at their command.

Mr. W. STIRK ADAMS described a case under the care of his colleague Dr. J. M. Smellie, in the General Hospital, Birmingham, some years ago, which supported the suggestion, raised during the discussion, that caloric tests carried out in the presence of labyrinthitis prejudiced the recovery of the patient.

The patient was a young man in the early twenties who was admitted to hospital for investigation of a left facial paralysis. His history was that six years previously a paresis of the left side of his face appeared after taking part in a cycle track race. The paresis disappeared within twenty-four hours, but recurred after every race, at first disappearing rapidly, but in the course of time taking longer to recover. He gave up racing for this reason some eighteen months before admission, but his facial paralysis did not recover and persisted unchanged until his admission for investigation.

General and neurological examination was negative apart from the paralysis of his left facial muscles, and deafness in his left ear. In this he was only able to hear a whisper at 1 in. distance. His left drumhead was intact, retracted, and almost immobile. Caloric tests were carried out to ascertain whether his labyrinthine function was affected. The evidence of the labyrinth tests and the presence of residual hearing proved a live labyrinth.

Within twenty-four hours of this caloric test the patient developed headache, a positive Kernig and neck rigidity: lumbar puncture obtained a C.S.F. containing several thousand cells per c.mm. Though the condition appeared to be of great gravity he made a rapid and uninterrupted spontaneous recovery, and within a few days the storm was past.

Shortly afterwards Mr. Stirk Adams explored his left mastoid which had been shown to be sclerotic by X-ray. The bone was eburnated and the lining membrane in the mastoid antrum and air cells was thickened. No exudate was present, and there was no cholesteatoma. Bone was removed to allow examination of the middle and posterior fossa and dura. No extradural abscess was present. He made an uninterrupted recovery from the operation.

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The speaker said it was clear that the meningeal reaction (meningitis aseptique) was produced by the use of the caloric tests in an ear which was the site of a chronic low-grade infection with an intact drumhead.

The PRESIDENT remarked on the diminishing number of complications such as brain abscess, meningitis or labyrinthitis. Where they saw ten cases in the old days they did not see more than one to-day. It was therefore more and more important that they should have clear-cut views as to how these cases should be treated when they did appear.

Concerning brain abscess his own viewpoint was rather altered from the time when, in consultation with a neurosurgeon, he was asked to say whether a brain abscess in the temporo-sphenoidal lobe was of aural origin. He gave the opinion that it was and intimated that an operation on the ear was desirable. That, however, was not first proceeded with, for the neurosurgeon decided to open the abscess through an osteoplastic flap in the temporal region. Later on he was asked to carry out the radical mastoid operation, with the result that the patient was still alive and perfectly cured.

That episode rather made him wonder whether they should always consult a neurosurgeon in these cases or not. He came to the conclusion that it was not always necessary, especially in those cases where the diseased track leading down to a rather superficial abscess was found in the first instance, and at the mastoid operation. It was his practice to drain brain abscesses with rubber tubes ; he had never resorted to aspiration. His cases had been few, but he had achieved successful results by putting in a tube and treating it carefully so as to disturb the surrounding parts as little as possible. On the other hand in cases where one was not quite certain of the track a neurosurgeon should be consulted.

Mr. E. D. D. DAVIS said, in reply to Mr. Watson-Williams, that the results obtained by the otologist were very much better than by the neurosurgeon. The otologist should be a general surgeon with a sound knowledge of neurosurgery and otology.

Neumann attributed his good results—47 per cent.—to the fact that he made an early diagnosis before the presence of naming aphasia. The acute, or subacute abscess might be fatal before the abscess was encapsulated. He supported Major Fowler when he said that the large majority of cases of otitic meningitis arose in the posterior fossa of the skull.

Mr. F. W. WATKYN-THOMAS said that he was glad to have so much support for his view about petrositis. He was convinced that the great majority of cases would subside with adequate mastoid operation. It was exceptional to have to carry out an actual operation on the petrous bone. He, too, inclined to the "heresy" that cholesteatoma was not itself infective, but by the time the otologist saw the cholesteatoma it probably was infected. Facial weakness after labyrinthectomy was not common. If a patient had a facial palsy before the labyrinth was operated on it complicated the condition considerably. Such palsies were not always recoverable, but from the results of ordinary labyrinth drainage (he was not referring to translabyrinthine drainage through the meatus) he could never remember getting a permanent facial palsy. He had once or twice found a transient weakness.

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Major Fowler's suggestion of making a little hole in the mastoid to give relief of pain in fulminating cases was very intriguing. He had been tempted to do it but up to now he had never summoned up the courage.

An interesting point had been raised by Mr. Donald Watson, Colonel Canfield and Mr. Stirk Adams about the possibility of flaring up trouble by a cold caloric test. He supposed it would be possible that just that amount of irritation, the setting up, so to speak, of a wave, however trivial, in the endolymph, might cause enough labyrinthine disturbance to trickle a dose of poison through one of the preformed tracks.

Mr. TERENCE CAWTHORNE did not think it was necessary to do the cold caloric test on the affected side though he did not share other speakers' fears of the consequences. As Hallpike, Fitzgerald and himself had shown, it was possible to do the hot and cold caloric on the sound side and to obtain, together with other indications, the required results.



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## THE GENESIS OF TYPICAL AND ATYPICAL CYSTS OF THE NASAL FLOOR

By K. BERNFELD (Jerusalem)\*

THE term cyst of the nasal floor is applied by us to prominences of the vestibulum of the nose, situated either just in front or behind the *apertura pyriformis*, extending to the lateral corner of the nasal floor and containing a liquid matter. They are certainly rather rarely encountered. As a result of our experience it appears, however, that small, soft cushions of the mucous membrane with no or only very little contents—we call them “atypical cysts” of the nasal floor—are considerably more common. If only rhinologists would not omit the lowest, most laterally situated corner of the nasal cavity in their routine examination—whether with or without the help of a speculum—the above-mentioned formations would not be compressed or escape attention. This point is especially stressed since it may help to clarify the genesis of these peculiar cystic formations.

The distinction between “typical” and “atypical” cysts has been made from a clinical not, however, from a genetical viewpoint.

Reference to this type of cyst was first made by McBride, Dunn, Chatellier (1892) and Zuckerkandl (1892-93), further by Knapp (1895). According to Laszlo, we owe the first microscopical study of this condition to Brown Kelly (1899). According to Arnoldi, approximately 72 cases had been published in the literature up to 1929. (As to the latest literature, the reader is referred to StClair Thomson, Laszlo and Terracol, the latter particularly for French authors.) Recently Hlavacek alone reported upon histological examinations in twelve cases. See also Stupka.

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## Nomenclature

In the English and American literature reference is made to these cysts under the designation of "*cysts of the floor of the nose*" (StClair Thomson) or simply of "*mucous cysts of the nose*" (Laszlo). In a similar way they are called "*mucous cysts*" (*kystes mucoïdes du seuil du plancher*) by French authors as e.g. Terracol, Baldenweck. The literature written in the German language prefers the term "*Nasenvorhofszyste*" (*vestibular cyst of the nose*) (Marschik, Kofler, Glas *et al.*) or "*Nasenfluegelzysten*" (*cysts of the *alae nasi**) (Weersma, Huizinga) or "*Naseneingangsysten*" (*cysts of the entrance of the nose*) (Uffenorde). According to Klestadt, two separate types are to be distinguished, viz. the genuine cyst, originating from detached ectodermal remnants of the embryonic clefts which he calls "*cysts of the facial clefts*" and a secondary type which, in his opinion, develops from the *ductus nasolacrimalis* or—if the cyst has a more medial position—the *ductus nasopalatinus*. According to that author, the typical cysts arise from disturbances of glandular development or by an embryonal extension of the lateral edge of the floor of the nose or, as a result of the retention of secretion. Gruenwald and Blumenthal also refer to them as cysts of the facial clefts or facial furrows.

Finally, mention should also be made of the term "*lymphatic cysts*" as has been suggested by Marx, owing to a resemblance he found in the epithelium lining the medial wall of such a cyst to that of the lymph vessels. The cyst described by Marx cannot, however, be compared to any of the others reported upon in the literature as nasal-floor cysts, since it contained a multi-layered, flat epithelium, with cornification of the uppermost stratum, in addition to hair follicles.

## Occurrence

According to several authors the cysts in the majority of cases occur bilaterally (Terracol) while others stress their unilateral character (Laszlo). Kofler described two cases with bilateral occurrence. Our own data show that occurrence on one side is slightly more frequent than on both sides but what struck us was the preference for the right side. The cysts are especially often encountered in the female sex. This is borne out by our own data at least as far as the typical cysts are concerned while the atypical cysts occur with equal frequency in males and females. As regards heredity, we are only in possession of one single observation (Kaschke).

## Clinical Picture

In typical cases the cyst occurs in the vestibule of the nose; depending on its extent, it can be palpated beneath the upper lip in the gingival

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pouch, or on the external side of the upper lip below the entrance of the nose. It invariably extends beyond the edge of the *apertura pyriformis*. As a rule, the cyst presents itself as a round formation, the size of a pea or nut, covered with normal mucous membrane, fluctuating and yielding to pressure. Not infrequently, these cysts are discovered by chance—as an accessory finding—since the patients have no symptoms which draw attention to their presence and are only informed of their existence by the examination. Even if the patient is able to feel the cyst with his own finger, it need not trouble him at all. Only if it grows to a certain size it may cause discomfort. The symptoms are rather typical and indicative of the growth of the cyst. At that stage the cyst may extend, on the one hand, to the anterior extremity of the lower turbinal (StClair Thomson) into the nose or it may, on the other, by a more or less intense bulging of the *alae nasi* or the upper lip disfigure the face. If cysts grow on both sides the face may assume the typical aspect of a Mongol Kalmuck (Terracol). A more or less intense degree of nasal obstruction, a feeling of tension in the nose and upper lip, moderate pain on chewing are the typical signs of a growing cyst. More rare are boring pains in the maxilla or forehead (Uffenorde) or pain radiating into the eyes (Hallat). Otherwise teeth and nose present nothing abnormal. Radiography reveals no dental cysts.

The nasal cysts contain an amber-coloured fluid of a serous, sero-mucous or purely mucous nature. Aspiration of the contents may, if the cyst is sufficiently large, cause wrinkling of the covering mucous membrane after the cyst has collapsed. There may—although this occurs very rarely—be a bluish discoloration of the covering mucous membrane (Terracol), which, as a rule, has absolutely the reddish tinge of the normal mucous membrane of the nose. Discoloration only occurs after the contents, which normally have a translucent ochre-yellow or honey-or amber-coloured appearance, is changed by inflammation of the nasal cavity or the cystic contents itself. Even without any recognizable inflammatory process of the nose the cyst itself may become subject to inflammation as it occurred in one of Marschik's and one of our own cases. The cyst may rupture and the contents escape—in the same way as in an acute abscess—according to the literature exclusively into the nasal cavity occasionally with resultant fistulae with permanent secretion (Halle). In Marschik's case, rupture occurred every few days and by pressure on the cyst in the *fossa canina* at the side of the nose the patient could produce the escape of pus at will. Inflammation of the cystic contents may run without suppuration too, as in our Case I. For no recognizable reason, in this case the patient developed pain, the cyst grew red, the mucous membrane more succulent and swelling reached beyond the edge of the gum. With the usual antiphlogistic measures the symptoms subsided in the course of a few days to re-appear no more

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than once during the subsequent three years. This case shows that between the two extremes of no reaction at all and a purely suppurative type with a tendency to rupture, there is an intermediate form of reparable inflammation with no rupturing.

For how long may a cyst continue to be present in an unchanged condition? In the literature the longest period is apparently that of 10 years reported upon by Kofler. From our own experience with typical but particularly with atypical cysts it appears that as long as the pads form a solid mass or contain but minute amounts of secretion, decades may elapse until the cyst makes itself felt that, however, as soon as the cysts have—so to say—entered the stage of clinical manifestation they easily fall a prey to numerous irritants, and more or less rapidly become subject to inflammation. Such irritative factors are not only all kinds of inflammation of the nose but also all those pathological processes of the nasal cavity which may come into contact with the cystic wall (swelling of the turbinals, spurs, deviation of the septum, etc.). Trauma may also play an important rôle in this connection (cf. a recent publication by Hlavacek).

## Diagnosis

The diagnosis offers no special difficulty if the cyst is found at its typical site within the soft parts, laterally and in front of the *apertura pyriformis* near the floor of the nose. Palpation from underneath the upper lip with simultaneous probing will at once clarify the nature of the tumour found there. Aspiration yields a translucent, yellowish fluid in which usually no cholesterol is contained. But there are dental cysts which do not contain cholesterol either (Darlington) while, on the other hand, Brueggemann was able to demonstrate that in the free part of the antrum cholesterol was also formed. As an aid in differential diagnosis this can, therefore, only be used in conjunction with other findings. Radiographically the cyst can be visualized by lipiodol (Laszlo). When performing aspiration care should be taken that strict asepsis is observed and that a sharp but not too thick needle is used, since otherwise suppuration may develop with consequent fistulation, which may require a tedious and difficult treatment. Laszlo mentions, by the way, one case in which inflammation followed lipiodol filling but could be controlled in time by enucleation of the cyst.

Before embarking upon a detailed differential-diagnostic discussion of the various types of cysts which may occur in this region, mention should be made of the inflammatory conditions of those parts of the nose which are in close vicinity of the cyst and, therefore, of importance, as e.g. furuncles of the entrance of the nose or *alae nasi*, septal abscess, swelling of turbinals and suppuration of the accessory sinuses.

First of all the important follicular or radicular dental cysts have to

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be excluded, preferably by radiography. Nasal cysts are further characterized by their not involving the bone, although there are, as a matter of fact, cases in which indentations and impressions of the alveolar process have been noted (Kofler) which were considered by Uffenorde as signs of atrophy occurring in response to the constant pressure of the cyst. This may, in our opinion, also lead to fixation of the cyst giving the impression of bone involvement, particularly if, owing to preceding inflammation, there are extensive adhesions between the bone and that part of the cyst lying on the floor of the nose. The atypical cysts, owing to their consistence, anyway show more fixation than the typical ones. The cysts may further be confused with *cysts of the ductus nasopalatinus*, and, representing remnants of the foetal communication between the mouth and the nasal cavity at the place where the primary and secondary palate grow together, are lined with epithelium which has no connection whatever with the parodontium of the teeth but in which a connection can be demonstrated with epithelial inclusions left over when the primary and secondary palate united (Neuwirth and Parma). At an advanced age, the *canalis nasopalatinus* may obliterate or may leave epithelial inclusions containing small secreting glands. In the event of a gingival or dental or nasal infection occurring, they may grow into cysts through the retention of fluid. The nasopalatal duct is further lined with pavement epithelium and is in this way distinguishable from nasal cysts. Such cysts are, moreover, situated nearer to the septum and only if its lateral expansion is excessive and it projects into the vestibulum may it provide differential-diagnostic difficulty.

There is one further point that has to be discussed in this connection. We have often found that on the nasal threshold, on a level with the *apertura pyriformis* or just behind it, the bone may show a flat projection—a *tuberosity*—which on rhinoscopy gives the impression of a very laterally situated eminence of the mucous membrane. While normally the lowest, most externally situated portion of the floor of the nose is caved in rather than flat, we have occasionally seen a prominence of this area recognizable in X-rays of the skull as well as by thorough rhinoscopy. *This bony protuberance occupies that point of the floor of the nose to which the nasal cyst is likely to extend.* It never extends beyond the *apertura pyriformis* and has, to the touch, the hard consistence of bone in contrast to the typical or atypical nasal cysts. Probing will reveal the consistence of this tuberosity. It is so far imperfectly understood to what this bony projection owes its existence. We are probably dealing with a physiological variation of the bone in the lowest, most anterior, corner of the nose which has a certain connection with the growth of the maxilla, the nose and the pneumatization of the maxillary sinus. Owing to its very site in the nasal cavity, this bony protuberance may be the cause of complaints, particularly if the nasal cavity is in itself narrow or has

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been narrowed down by septal deviation or swelling of the lower turbinal. If—as it occurred in one of our cases—a cyst of the nasal-floor is superimposed on this bony protuberance, this combination all the more gains pathogenetic significance. The results of studies on the bone variations of the anterior, lateral nasal corner—as outlined in the foregoing—will be the subject of another publication.

These eminences should be distinguished from those due to an excessive length of a dental root. Radiographically, the so-called “*Gerber's pad*” (bulging of the lateral wall of the nose towards the nasal cavity caused by abnormality of the upper incisors and canines) is easily distinguishable from the bony tuberosity.

Bustin was the first to draw attention to a globe-shaped bulging of the floor of the nose, bordering on the septum, just above the medial incisors as they develop in their cavities before breaking through in the fifth or sixth year.

For the sake of completeness it should further be pointed out that *Gerber's pad*, which is pathognomonic of median maxillary cysts (Marschik), occurs behind the lower edge of the *apertura pyriformis*, below the anterior extremity of the lower turbinal, usually in the middle of the floor of the nose. Glas calls a cyst of the nasal antrum found on the nasal-floor and markedly bulging beneath the lower turbinal a “*Pseudo-Gerber prominence*”, creating the impression as though one were dealing with a maxillary cyst. All these prominences are soft and elastic and thus easily distinguishable from the bony protuberances.

### Pathogenesis

The discussion on the pathogenesis of the cysts of the nasal-floor is characterized by the conflict between two opposing theories. According to the one, we are dealing with genuine retention cysts deriving from the neighbouring nasal mucous membrane. The special predisposition consists in a special length of the glandular ducts (Sappey's ducts) connected with the respiratory epithelium of the nasal mucous membrane (Chatellier, Brown Kelly). Recently Hellat, Kofler and Marschik have joined the supporters of this theory. The second theory regards the cysts as malformations, which according to Tueffers, Monesi, Peter and particularly Brueggemann, derive from the rudimentary anterior portion of the lachrymal duct. This theory has, however, been opposed by Uffenorde and Doering. Wyatt Wingrave presumes a connection with the Organ of Jacobson or its rudiments—a theory which seems to have been completely abandoned. Gruenwald, Grosser and Malan believe that the cysts develop from the canal of Stensen which is said to be, in humans, the equivalent of the *canalis incisivus*. Grosser found the germ of the nasal gland of Stensen in human embryos too, behind the vestibulum at the lateral wall of the nasal cavity. These

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findings found corroboration by Peter and Klestadt. But Doering is right when he points out that so far not one single case of a cyst which might have developed in this way has been reported; and Uffenorde draws attention to the fact that such a cyst should be expected to occur on the *agger nasi*, i.e. in the upper part of the *ala nasi* rather than in the lower meatus or on the floor. This mode of development may, therefore, be altogether neglected. (Mention should also be made of Zarniko's theory which has, however, also been abandoned, and according to which the cysts owe their existence to retrograde changes of the cartilage (softening).) Finally, there is the theory put forward by Klestadt which is generally accepted at present, according to which the cysts derive from detached germ material in connection with the facial clefts. This opinion has been adopted by Uffenorde, Huizinga and Doering. Although this theory is not completely satisfactory either, it is the one which explains the major part of the facts, as we were able to confirm on our material. Arnold points out that in disagreement with his own theory, Klestadt was unable to detect, in embryos, epithelial islets in the area in question. According to Peter there is neither a cleft nor a growing together of epithelial surfaces facing each other between the maxilla and the lateral nasal process, which would be the precondition for the detachment of ectodermal inclusions. Nevertheless, the theory establishing a connection with the facial clefts is the most probable one, and furnishes the easiest and simplest explanation for the occurrence of cysts of the nasal antrum owing to the frequent occurrence of developmental disturbances of the eye-nose line congenital fistulae of the corner of the *alae nasi*, the upper lip, in the area below the *alae nasi*, in the upper portion of the eye-furrow (Vogel quoted from Doering) as well as "cysts of the facial clefts of the naso-ethmoidal border region" to which Klestadt has again called attention. Blumenthal believes that the cysts derive from epithelial cells remaining over from the development of the maxillary bone.

Pathologic-anatomically, the cysts have to be considered as hamartomas or histoid teratomas (Uffenorde) whether they have developed from the nasolachrymal duct or are connected with the facial clefts. In their structure, therefore (according to Uffenorde) they may either resemble the outer skin or the mucous membranes. It was Uffenorde who described the only case reported upon in the literature in which the mucous membrane contained inclusions of flat epithelium—apart from the case of Marx quoted above. Why it is particularly the mucous-membrane type of these hamartomas that out-numbers the other, is as yet imperfectly understood. In agreement with Uffenorde and Doering we would say that the histology alone does not suffice to clarify the genesis of these cysts (since naturally those deriving from the nasolachrymal duct and from facial clefts develop from the same type of

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embryonal tissue) but that their relationship to neighbouring structures and their localization should be carefully studied (Doering). Clinical considerations also indicate that only an accurate study of local manifestations will solve the genetic problem.

The most striking feature is the *solitary* appearance of the nasal-floor cysts. In none of our cases, nor in any one reported upon in the literature, has multiple multilocular occurrence on one side been noted. The mucous membrane of the nose possesses an abundance of mucous glands so that retention cysts would have to appear in many different places and much more frequently than is the case. Moreover, the development of these cysts at the lateral wall of the nasal cavity where, owing to developmental reasons, there are many folds and eminences, is sufficient proof of the fact that we are not dealing with retention cysts. However wrinkled and crooked the middle meatus may be, retention cysts in this locality are a very rare event. It may naturally happen that now and then the very character of the mucous membrane of this part may act as an irritant responsible for the strangulation of a glandular duct or a portion of the epithelium and consequently leading to retention—as we have seen it in one of our cases (*Folia Otolaryngol. Orient.*, Vol. I), but this is an extremely rare event. It is not only the fold or the unevenness but the embryonal union between ecto-and mesodermal tissues that furnishes the basis for these abnormalities. Irritation of the nose cannot be altogether excluded even if at the time of examination no symptoms are present. The regular occurrence, however, of the nasal-floor cysts at certain places of predilection, bilaterally and symmetrically, must have a deeper reason which can only be explained by a developmental process as e.g. that suggested by Klestadt. We ourselves have not made histological studies concerning this point, but we have at our disposal a remarkable number of cases which we could follow up clinically. The clinical appearance alone with its definite localization is indicative of a connection with the development of the nose and maxilla (union of the primary lateral nasal process with the maxillary process). However, during the genetical process parts of the mucous membrane have become detached or have been drawn into the depth, there is no reason why a retention cyst should not develop. Any irritation may make it grow, and possibly the growth of the cyst itself leads to more or less severe embarrassment of circulation within the cyst, thus enhancing retention of fluid. The objection that retention cysts have never a lining of ciliated epithelium is only valid if we are dealing with typical glandular retention cysts of the nose with their typical, regular uni-layered epithelium. From a merely mechanistic view-point any cavity, any cleft which is lined with epithelium, is capable of secretion and may thus give rise to the accumulation of fluid in the absence of an outlet or, in other words, to the formation of retention cysts.

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The two theories—the one referring to development and disturbances, the other to retention as the active factor in the production of nasal-floor cysts—do not necessarily exclude, but rather supplement, each other. Congenital inclusions on the basis of which the cysts develop are probably always present, and a suggestion of nasal-floor cysts—in the form of atypical formations—is, therefore, comparatively frequent. Genetically the fully developed, typical cysts with a liquid contents are identical with the atypical formations with little or no contents at all. The appearance of a retention cyst marks the *second* stage in the development of these structures. According to the glandular theory, advancing growth of the glandular duct would intensify the occlusion, thus enhancing the retention of fluid. In the event of primary obliteration of the duct or secondary fibrous conversion (cf. histology) no retention cysts develop and we find an atypical cyst. According to Klestadt's cleft-theory the development would have to be envisaged in the following way: The epithelial islet is a solid mass with secretion into an already existing cavity by its goblet-cells, an abundance of which is found intermingled with the cylindrical cells. Further, circulatory factors and irritation within and around the epithelial inclusion lead to serous transudation from the blood and lymph vessels into the steadily expanding cavity, thus creating a retention cyst. This is what makes Klestadt's theory so enticing, explaining at the same time the dispositional factor as well at the secondary stage of cyst formation in a very simple manner. According to Gruenwald, by the way, detached epithelial germs may also in the absence of clefts lead to the development of epithelial cysts, simply by occlusion of surface folds, in adult life too. The nose, as a matter of fact, is exceedingly rich in folds. However, owing to the rare occurrence of cysts in the nose the dispositional factor, as outlined by Gruenwald, and consisting in a particularly extensive wrinkling of the mucous membrane of this part may not carry very much weight. It is impossible to explain the comparative frequency of the cysts without the cleft-theory. But whatever the genesis may be, the cystic stage must necessarily be regarded as a secondary event superseding the stage of solid epithelial growth. Bauer's observation that cysts of the nasopalatine duct may already occur in embryonal life does not contradict our theory implying that cyst formation is a secondary process, since the reason underlying the formation of cysts is already present at that time, as mentioned above.

The congenital genesis of nasal-floor cysts is further evidenced by their *symmetrical, bilateral appearance at certain places of predilection*, as pointed out in literature, and as we were also able to observe in our own cases.

We now proceed to an analysis of the non-reactive preliminary stage, that of the epithelial islet. Changes within a cyst which until then has

been free from inflammation may occur after years of its existence as e.g. in the following case :—

The patient was a 39-years old woman whose information could be relied upon. From about 8-10 years she had noticed a nodule, the size of a pea, in the anterior part of her nose, which felt hard to the touch. For years she had known of the existence of this " polypus " which did not, however, cause any trouble at all. Lately she had noticed that the tumour had grown and, what made her particularly anxious, had become softer. Examination revealed a typical antral cyst which, for no clinically recognizable reason, had suddenly started growing. Since the wall of the cyst showed no pathological changes and since, further, the contents were clear and contained no inflammatory elements, it had to be assumed that we were dealing with a non-reactive growth of a cyst. That enlarged retention cysts are likely to fall a prey to inflammation is obvious if only in view of the mechanical irritation of the steadily growing cyst. Apart from inflammation, the enlargement of the cyst may also be due to simple non-reactive development from an apparently solid but certainly atypical formation.

The *third stage* in the development of nasal-floor cysts is marked by *suppuration and fistulation*—the stage of exteriorization. This may also occur in the absence of clinically recognizable changes of the nose and adjacent tissues. This would also explain Marschik's case. From a clinical viewpoint, it is interesting to note that in the majority of cases no manifest inflammatory reaction of the nose and its neighbourhood can be ascertained, so that we have to confine ourselves to the supposition that the presence of inflammatory, traumatic or circulatory processes not amenable to clinical recognition and which may provoke an inflammatory reaction within the cyst itself up to the degree of suppuration. The presence of such a cyst in embryonal life (as in Bauer's case of a nasopalatine cyst) shows that probably circulatory factors alone are able to transfer a solid epithelial inclusion to the cystic stage.

The solid epithelial islet may retain its solid character with eventual central degeneration, but an atypical or a typical cyst may, on the other hand, be replaced by fibrous proliferation, that means it may from the inflammatory stage merge into that of fibrous healing.

Summing up it may, therefore, be said that a *solid epithelial inclusion may either persist or be converted into a cystic formation*. It may grow independent of presence or absence of inflammation in the nose and the first stage is that of a non-reactive congestive (retention) cyst. Here a *transitory, reparable inflammation* or, on the other hand, *suppuration and fistulation* may develop. In any of these stages fibrous conversion may take place.

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## Histology

In the foregoing an attempt has been made on the strength of clinical evidence to clarify the pathogenesis of antral cysts, and it could be concluded that only developmental factors, as e.g. those put forward by Klestadt, would be able to explain all the facts. Microscopical studies are unable to contribute anything to its pathogenesis. As a result of our investigations it appears that the nasal-floor cysts are of an entirely benign nature, the only exception being reported upon by Arnoldi, who noted carcinomatous degeneration within a cyst—a unique event as far as borne out by the literature.

Histologically the picture presents itself as follows: Underneath the epithelium we find a firm fibrous tissue which further down in the depth becomes relaxed, occasionally oedematous. Here and there the fibrous tissue contains a rich network of blood vessels with varying degrees of lymphocytic, leukocytic or plasma-cellular infiltration usually surrounding the blood vessels. Outside the fibrous layer there are varying degrees of accumulations of mucous glands (Laszlo). The cyst itself contains—with very few exceptions—no glandular elements (Beck, Uffenorde, Doering). In the case in which we performed operation no glands could be demonstrated either. It is interesting to note that Brown Kelly, to whom we owe the first microscopical studies on this condition, actually found glandular elements, which led him apparently to the conclusion that he was dealing with a retention cyst although his intuition and keen observation made him already suspect its congenital character (this coincidence—at least to some extent—with Klestadt's theory has been pointed out by Doering). The epithelium is, as a rule, of the cylindrical type, one-layered, but also two-or multi-layered with and without ciliae. The ciliae may either be well-developed and form a delicate seam but may also show any degree of damage as a consequence of inflammation or as a result of pressure within the cyst acting either slowly or rapidly. The cylindrical epithelium is usually interspersed with numerous mucous-producing goblet-cells. In the presence of inflammation, a considerable degree of cell migration through the epithelium is noted and the cystic lumen contains cell detritus and leucocytes, an event that, apart from the damage it does to the ciliated seam, is also marked by transformation of the cylindrical epithelium into the cuboid, multi-layered type. In a case reported upon by Blumenthal the epithelial cover had completely disappeared as a result of inflammation. (As to histology cf. also Arnoldi, Beck, Brueggemann, Hlavacek, Kosler, Laszlo, Uffenorde.)

It is generally known that the mucous membrane of the *vestibulum nasi* is characterized by a multi-layered pavement epithelium with no glandular elements (Chiari, Zarniko) so that the cyst of this region

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appears as a foreign structure, although Marx and Uffenorde refer to the occurrence of cysts lined with flat epithelium in this region.

The higher the degree of perivascular infiltration, cell migration, etc., within the cyst the farther are removed from the stage of mere congestion and the closer do we approach that of inflammation.

The fibrous conversion as mentioned above will have to be the subject of further histo-pathological studies.

No definite conclusions as to the genesis of the cysts can be derived from the microscopical findings. In view of its structure the cyst may originate from the epithelium of the nasolachrymal duct as well as from that of the facial cleft. The only valuable information is furnished by the histological studies with regard to the development of the cyst from its solid phase into that of suppuration and further with regard to the differential diagnosis between dental cysts and genuine antral cysts of the nose, although, as already mentioned above, in this respect the evidence is not always conclusive either.

## Therapy

As long as the typical or atypical cysts are small and cause no symptoms any kind of treatment is superfluous, nor will it be possible to obtain the patient's consent. If, however, the growth of the cyst, suppuration, or whatever reason makes its removal imperative, the procedure should be a radical one by peroral approach underneath the upper lip. The operation should be followed by cauterization which ensures a firm scar. Several French authors are in favour of tamponade which, in their opinion, causes the scar to grow from the depth to the surface (Terracol). Recently others, e.g. Laszlo, reported satisfactory results and healing by first intention after suturing, a method which we have also used to advantage.

Among conservative measures, aspiration followed by instillation of tincture of iodine, zinc-chloride has its dangers too. In one case four aspirations with subsequent instillations of two to three drops of a 10 per cent. tincture of iodine effected a shrinking of the cyst for more than two years. There can, however, be no doubt that repeated puncturing of the cyst may be followed by suppuration so that very strict observance of aseptical precautions is an indispensable pre-condition. If patients are afraid of operation and the cyst grows, conservative methods are always indicated even if there is a suspicion of inflammation. The peroral radical operative removal of the cyst does not, to judge from the literature, lead to complications and ensures satisfactory results. Calderin advocated operation by a nasal approach, a method which has not been approved by others.

# Typical and Atypical Cysts of the Nasal Floor

## Report of Cases

The total number of cases presenting typical nasal-floor cysts was three, that of atypical ones 21; four of the patients were children (three girls of 8, 11, and 12 years respectively, one a boy of 7); 17 were adults (nine men and seven women between 28 and 38 years of age).

The cysts occurred unilateral in 13 cases (in 8 on the right) and bilaterally in 8.

The following are abstracts of the records of a few interesting cases.

**CASE I.**—For many years the patient, a woman of 38, had been aware of the presence of a soft eminence, on the right, on the floor of the nasal antrum which she could feel with her little finger, without paying particular attention to it. Four years before she consulted us the tumour had begun to ache, the nose was on that side somewhat obstructed, there was a feeling of tension in the upper lip and when lifting the tip of the nose a tumour was easily recognizable and could also be palpated from the gingival pouch.

*Diagnosis.*—Typical nasal-floor cyst of the nose. The teeth were in order. Aspiration yielded a serous fluid and in conjunction with the instillation of a few drops of a 10 per cent. tincture of iodine effected the subsidence of the inflammatory symptoms. Only after the lapse of two years the cyst had refilled without inflammatory manifestations. Up to this day (five years) it has remained unchanged.

**CASE II.**—The patient was a girl of 8 years of age. There was no hypertrophy of the turbinals especially nor even a suggestion of swelling of the anterior extremity of the inferior turbinal. On the left, in front of the *apertura pyriformis* there was an elastic eminence, the size of a pea, causing slight protrusion of the upper lip. Aspiration negative. A typical, solid antral cyst of the nose.

**CASE III.**—The patient was a boy of 7 with adenoid vegetations. Quite accidentally button-shaped, solid, symmetrical tumours were found in both vestibula; on the right palpable from the gingival pouch, on the left not palpable. The left tumour seemed to lie on a bony tuberosity of the lateral corner of the floor of the nose. The teeth showed nothing abnormal.

**CASE IV.**—The patient, a man of 41, had undergone tonsillectomy. For a few weeks he had complained that his nose felt obstructed. There was hypertrophy of the turbinals on both sides. On the left the lower turbinal with its utmost extremity almost touched the floor of the nose, in the typical corner of the floor. Under this with a probe the tuberosity could be felt at the typical site. Radiographically the teeth were normal. In this case swelling of the turbinal closely approaching a bony tuberosity created the impression of a nasal-floor cyst of the nose.

**CASE V.**—The patient was a 30-year old woman who was suffering from chronic rhinitis. Examination of the teeth and nose revealed nothing abnormal. On the right, there was a nut-sized cyst lying on the floor of the nose which had been present for several years. A few days before the patient consulted

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us it had, for no recognizable reason, become red and swollen. Upon treatment with hot poultices, Sollux and hot irrigations the symptoms subsided, to re-appear after three years. The mucous membrane assumed a colour as though it was covering an abscess but there was no suppuration. After the acute symptoms had subsided I removed the cyst by the buccal approach. The histological examination showed marked perivascular infiltration of plasma cells and leucocytes. The epithelium was of the cylindrical type with interspersed areas of severely damaged ciliation. The connective tissue showed marked hyperæmia. We were dealing with inflammation of a typical nasal-floor cyst of the nose.

CASE VI.—The patient, a man of 28, had a spur on the left side of the septum. On the same side there was, in the nasal vestibulum, extending over the floor of the nose, an eminence, the size of a cherry-stone, into which the spur protruded. Ischaemia left this formation unchanged. It felt bone-hard to the touch and did not yield to pressure from a probe. Otherwise there was nothing abnormal, particularly no excessive length of the incisors which could be verified by radiography. This case provided a classical illustration of the harmful effect of the presence of bony protuberances of the lateral corner of the floor of the nose (clinically, firm eminence of the mucous membrane) which, owing to a pathological shape of the nose (spur) became particularly troublesome, the patient complaining of obstruction of the nose and epistaxis on that side. Removal of the spur made the symptoms disappear.

CASE VII.—The patient, a chemist who was 38 years old, presented the following findings which were obtained quite by accident. There were, in both vestibula of the nose, millet-sized symmetrical eminences of the mucous membrane, flatly spreading and readily yielding to pressure. No palpation from the gingival pouch was possible. Aspiration yielded, on the right, a few drops of a serous fluid, on the left, nothing. After three years, aspiration on the right was also negative (obliteration of the cyst? Fibrous conversion?). The symmetrical arrangement, the positive aspiration on the right suggested that the solid formation on the left (atypical nasal-floor cyst) might owe its existence to the same mechanism.

CASE VIII.—The patient, a girl of 24, showed thickening of the anterior septal portion on both sides. On the right, there was, moreover, a distinct bony eminence on the typical site of the nasal floor, while the teeth were normal. On the left there was an elastic prominence of the vestibulum nasi lying upon a bony tuberosity; it only slightly yielded to pressure and underneath the bony resistance could be felt. It was not clear whether we were dealing with an atypical cyst lying upon a bony tuberosity or a cushion of the mucous membrane of the nose overlying the tuberosity.

The remaining case histories were almost always in accordance with one of the types outlined above.

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# BILATERAL PERFORATE NASOPALATINE COMMUNICATION IN THE HUMAN ADULT

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## Nasopalatine Canals

A GOOD deal of confusion seems to prevail concerning the status of the nasopalatine passages (incisive canals) in the normal adult human subject, and also with regard to their relationship to the rudimentary organ of Jacobson (vomero-nasal organ). Knowledge is lacking relative to the frequency in this region of the persistence of foetal conditions. The existence, bilaterally, in one of us (H.M.D.), of complete, patent passages connecting the buccal cavity with the floor of the nasal fossa prompted us to investigate the detailed arrangements and the effects thereby produced, with a view to shedding light on the above problems.

## Normal Anatomy

In the median line of the bony palate, immediately behind the alveoli of the central incisors, and therefore interrupting the intermaxillary suture, is the incisive foramen (anterior palatine canal). It is described as funnel-shaped, with the stem of the funnel directed towards the nose and bifurcating at the top so as to gain an opening into the floor of each nasal fossa near the angle formed by its union with the nasal septum. The two passages so formed are termed the foramina of Stensen. Ordinarily they transmit some anastomotic vessels connecting the posterior palatine arteries with the arteries on the fore part of the nasal septum. Inconstantly, two smaller foramina, the foramina of Scarpa, occur mesially within the incisive foramen, one anteriorly and one behind, the former transmitting the left nasopalatine nerve and the others its fellow (*vide* Thompson, 1915; Gray, 1942).

The upper and lower ends of all these passages are normally closed by mucous membrane and submucous connective tissue, but at the nasal end there is "sometimes" (Cunningham, 1943) a funnel-shaped pocket in the mucosa overlying the upper end of the incisive canal, or more particularly the foramen of Stensen. This constitutes the nasopalatine recess and its frequent presence is readily confirmed in fresh subjects in the dissecting room. It is directed downwards and forwards and is blind; but it indicates the site of a prenatal connection with the buccal

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## Bilateral Perforate Nasopalatine Communication

cavity. "Occasionally" (Schäfer and Symington, 1909) a narrow, blind, funnel-shaped tube of mucous membrane passes obliquely downwards towards the palate for a short distance. The recess was stated by Keibel (1912) to be caused by imperfect fusion of the participating embryonic structures entering into the formation of the palate. Although the epithelium becomes continuous maybe on both nasal and buccal aspects, the underlying mesoderm does not, a strip of solid epithelium passing through it from the nasopalatine recess to the incisive fossa of the buccal surface. This epithelial strip indicates the line of fusion between the palatal process and the processus globularis. Should the cells of the epithelial cord break down, a nasopalatine canal (ductus incisivus or canal of Stensen) results and, though normally disappearing prenatally, it may persist for some time after birth.

Little information is available relative to the state of affairs on the palatine side in Man. In many mammals, especially ruminants, pigs, etc., there are two slit-like openings in close proximity to a median raised pad (incisive papilla or papilla palatina) of mucosa, situated at the front of the hard palate, immediately posterior to the alveolus. These openings lead upwards into tubular Stensen's canals (occupying Stensen's foramina) which communicate freely with the nose. Padgett (1938) declares the incisive papilla to be present normally in Man and to be connected, in infants prior to the eruption of the central incisors, with the frænum labii superioris. This is normally the case in some primitive lemuroids where there is a diastema between the two central incisors. Sometimes, in Man, a small pit occurs in the palatal mucous membrane on either side of the median line behind the papilla. It is rarer than its nasal counterpart and when present it is blind. Roper-Hall (1940) states that it is possible to pass a bristle into a recess both nasally and palatally in some anatomical specimens, but apparently they do not usually join. This author also states that, though the nasal pockets are usually small and their orifices of uniform size, the palatal recesses vary in size, shape, angularity and depth.

Specialist works on oto-rhino-laryngology evidently regard all these manifestations of no special importance, for they omit all mention of them (e.g. Tilley, 1919; StClair Thomson, 1926; McKenzie, 1927; and Logan Turner, 1932) with the exception of Jackson and Coates (1930), who state that nasopalatine canals may remain open in the adult, though the frequency of such occurrence is not given. Padgett's (1938) work on the mouth and jaws is more informative, for attention is here drawn to the possible connection between nasopalatine canals and epithelial cysts in the neighbourhood of the upper incisors, an aetiological association which has been further elaborated recently by Roper-Hall (1938, 1940, 1943) and by Brandt and Roper-Hall (1941).

Regarding the frequency of patent nasopalatine canals in Man,

Wiedersheim (1895) states that even in embryos they are only exceptionally found open. This author avers that usually there are paired canals open on both nasal and palatal surfaces, but apparently united at an obtuse angle whereat each ends blindly. Traces of the buccal ends sometimes persist in the form of epithelial strands in the adult; but generally they disappear, whereas the nasal tubes more frequently persist.

More recent investigation by Rawengel (1933), who serially sectioned material from 19 newborns and 8 adults, showed patent canals in 5 of the former; 3 adults showed no degree of patency. Four specimens (1 newborn, 3 adults) had a blind sac opening buccally, whilst 14 (10 newborns, 4 adults) possessed a nasopalatine recess with nasal orifice. These data are somewhat ambiguous as to the frequency and bilaterality of complete nasobuccal patency, though this would appear to be restricted, if present in any, to the newborns. Schroff (1929), however, quotes Rawengel differently as listing one adult with a (? unilateral) continuous passage. Roper-Hall (1944), in a study of Jacobson's organ, found it present along with a patent nasopalatine canal in a single adult out of 20 studied. It is not stated, however, whether this was a continuous passage or merely an unusually deep nasopalatine recess. In any event, it is quite clear that complete nasobuccal patency is an extremely rare condition, especially in the adult.

It should be stated that Jacobson's organ is an anatomically separate entity from the nasopalatine canals, though the two structures are physiologically associated in animals in which they are of functional importance. Jacobson's organ is comprised by bilateral blind epithelial tubes opening on the lower front part of the nasal septum immediately above and slightly anterior to the nasal end of the nasopalatine canal (or recess) of its own side. From the opening, the tube extends upwards and backwards to a varying degree: in Man, from 1.5 to 6 mm. (Piersol, 1907). Wiedersheim regards the organ as normally present, but vestigial in Man, though it may degenerate on one or both sides. In animals with a functional organ of Jacobson the association with the nasopalatine canals may be much closer (e.g. horse, ruminants, pig, *vide* Sisson, 1938) the opening of the former being within the nasopalatine passage, giving thus a common buccal opening for the two.

The papilla palatina or incisiva is a specialized area of raised palatal mucosa separating the buccal orifices of the nasopalatine canals, and extending forwards therefrom to the alveolar process, where, in the embryo, newborn and, in some animals (e.g. *Loris*) even in the adult, it may be connected with the frænum of the upper lip. Wiedersheim quotes Meckel as authority for its having a sensory function, and it is significant that the tactile sensation elicited on this part of the palate differs considerably from that experienced elsewhere.

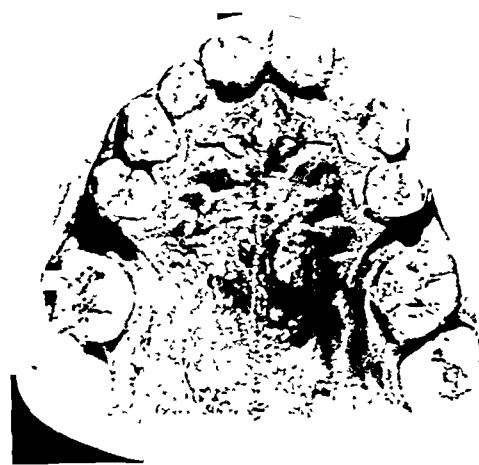


FIG. 1. Photograph of plaster cast of palate, showing incisive papilla and marks at its posterior end indicating site of buccal orifices of nasopalatine canals.

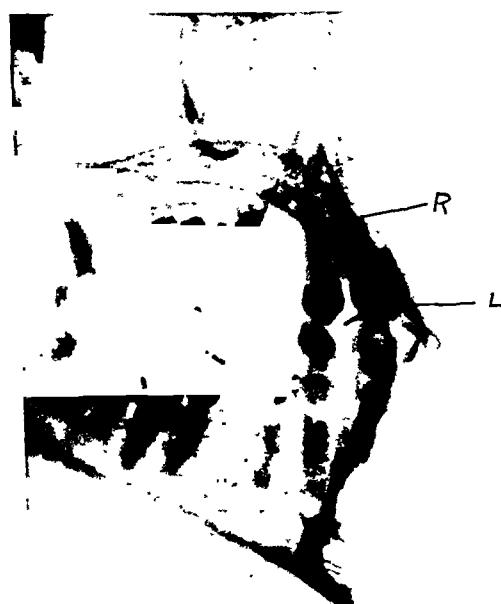


FIG. 2. Lateral radiograph with wires in nasopalatine canals. R. upper end of wire in right canal : L. lower end of wire in left canal.



FIG. 3. Antero-posterior radiograph. Wires visible in both canals. L. points to thin wire in left canal.



FIG. 4. Oblique supero-inferior radiograph. Wires visible in both canals.

# Bilateral Perforate Nasopalatine 'Communication

## History and Investigation of Present Example

For some years one of us (H.M.D.) had noticed that, on sucking hard with the mouth closed, a curious high-pitched squeak could be emitted and this appeared to originate in the roof of the mouth. It was also observed that this phenomenon was accompanied, especially in cold weather, by injection of a jet of cold air and salty fluid, which appeared also to come from the hard palate in the region behind the incisors.

Investigation revealed the presence of a well-marked antero-posteriorly elongated incisive papilla (9 mm. long) in the usual position (*vide* Fig. 1) but no openings could be detected visually. Introduction of a coloured dye (methylene blue) into the right nostril, followed by a slight suction, rendered evident the patency of a passage through the palate, for the dye was readily detected streaming into the mouth from a position close to the posterior end of the incisive papilla, and at least half-an-inch behind the lingual surface of the central incisors. Similar effects were produced on the left side, but only with much more powerful suction.

In order to ascertain the anatomical relations and also for radiological examination, an attempt was made to pass wires along the canals. A fine steel wire probe, an inch long, was passed readily along the right canal from below upwards. The palatal opening of the passage was discovered alongside, and slightly overlapped by, the edge of the posterior part of the flabby incisive papilla. By anterior rhinoscopy, the upper end of the wire could be seen projecting from the nasal-floor, close to the septum. The operation was accompanied by a tingling sensation in the nose, but was not painful. On the left side it was found necessary to employ a much finer wire before penetration occurred and even then the operational was painful, though the pain arose entirely on the palatal side of the passage, giving the impression of either a stricture or a kink at that end.

The internal anatomy of the nose has unfortunately been somewhat changed by an earlier (3½ years) submucous resection of the septum necessitated by a serious deflection to the right anteriorly and to the left posteriorly, and accompanied by a sharp septal spur. This abnormality was congenital and not traumatic. The modifications produced, however, do not appear to have affected the patency of the nasopalatine canals nor their anatomical relationships. They did, however, preclude any attempt to investigate the possible presence of Jacobson's organ.

After insertion of the wires, radiographic exposures were made in the antero-posterior, side to side and supero-inferior planes. The results are depicted in the accompanying plate (Figs. 2, 3 and 4). The wire inside the larger right canal is well seen in all the exposures; but the finer wire in the left passage can be made out in the antero-posterior

and better still in an oblique supero-inferior exposure (Fig. 4). Both canals are seen to have an inclination from below upwards and backwards, parallel with the slope of the facial surface of the pre-maxilla. The right canal is quite straight, but the wire in the left canal is somewhat kinked and slightly concave laterally in the antero-posterior radiograph. The two canals are therefore divergent as they approach the nasal septum the thick lower end of which can be observed inserting on the nasal floor between them. This is further corroborated by the supero-inferior exposure.

The following further observations were made on the nasopalatine canals. The only effect of nasal catarrh is the blocking of mucoid flow from the nose to the mouth by participation of the epithelial lining in the general congestive swelling. Smoking encourages mucoid discharge, but tobacco smoke cannot be forced upwards from mouth to nose, due presumably to the valvular effect of the thick lateral edge of the incisive papilla bordering the palatal orifice of each canal. Cold (e.g. sucking ice) opens the canals from constriction of the lining membrane. Shock causes a similar effect, possibly due to vasomotor constriction. Substances (fluids) with characteristic tastes introduced into the nose can only be tasted after suction into the mouth. Vapours (e.g. chloroform) cannot be sensed in this way.

## Discussion

There is no reasonable doubt that the nasobuccal communications herein described are persistent nasopalatine or incisive canals. Known previously as patent only for a short time during early prenatal life, they were occasionally understood to persist till some time after birth; but persistence in the adult, apart from very occasional blind mucous pouches on nasal or buccal aspects of the hard palate, is justifiably regarded as of extreme rarity. The present instance at least demonstrates that it can occur and without causing inconvenience. The completeness and, especially on the right, the wide patency must be quite phenomenal. It is probable that canals as well developed as these would be unlikely to give rise to cysts. It is the less patent type of canal that would conceivably act as basis for cyst-formation by stenosis or occlusion at one or both ends by a mucous or epithelial plug, thus leading to its recognition. Closure of the slit-like palatal orifice by the valvular action of an enlarged or oedematous incisive papilla would, no doubt, produce a like effect. Possibly, therefore, the larger patent canal may be commoner than has been recognized because its presence would remain unnoticed by the lay patient, or, if noticed, would probably be-regarded, since it causes no inconvenience, as a normal condition. The inability to taste fluids introduced into the nose unless they are sucked through into the mouth suggests that Jacobson's organ was absent or functionless,

# Bilateral Perforate Nasopalatine Communication

but the former possession of a septal spur suggests the occurrence of a large Jacobson's cartilage.

We have to thank Professor J. C. Brash for his interest and criticism in the preparation of the above account and to acknowledge the help of Mr. J. Borthwick of this department for the photograph reproduced in Fig. 1.

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# THE CONSERVATIVE TREATMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA

By R. SCOTT STEVENSON, Major R.A.M.C. and  
J. CHALMERS BALLANTYNE, Captain R.A.M.C.\*

THE treatment of the "running ear" is undoubtedly one of the major problems confronting the Army Otologist. In *The Ear, Nose and Throat in the Services*, one of the present authors<sup>x</sup> states that, of all cases referred to the Ear, Nose and Throat Department of a Military Hospital in a large home command, 60 per cent. were aural cases, and that of these 65 per cent. were cases of Chronic Suppurative Otitis Media. Men with active disease of the middle ear are fit for only limited service overseas, yet in the present hospital, 38·75 per cent. of all cases referred to the Ear, Nose and Throat Department during the past year were aural cases, and of these 31·6 per cent. were cases of Chronic Suppurative Otitis Media.

We feel that the vastly superior results of treatment by dry methods over wet justify our practice of treating all such cases initially by the insufflation of some form of powder; but the striking results obtained by zinc ionization in certain resistant cases would seem to warrant its inclusion in any schema of treatment before resorting to radical operation. This paper contains some general remarks on the technique of treatment by dry methods and detailed results of treatment by two new powders—Sulphathiazole ascorbate and Sodium penicillin-sulphathiazole.

## (A) Dry Methods

### (i) TECHNIQUE

It has long been recognized that the most important single factor in the successful treatment of Chronic Suppurative Otitis Media is thorough toilet of the ear, before any powder or solution is introduced. The technique we employ is as follows:—The ear is thoroughly mopped with cotton-wool on a Jobson Horne probe under direct vision, until the meatus is free of all discharge and debris. Any granulations are touched with a 20 per cent. solution of silver nitrate until blanching is seen, and the middle ear is finally cleared by Eustachian catheterization and suction with a Siegel's speculum. The powder is then insufflated very gently until a frosted-glass appearance is seen on the drumhead—the process of "frosting".

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# Treatment of Chronic Suppurative Otitis Media

## (2) THE POWDER

Various powders have been used, and until recently we treated every case, in the first instance, with 1 per cent. iodized boric powder—with a large proportion of successful results. Sulphanilamide and Sulphathiazole have each been used separately, but with no notable advantage, and the use of a Sulphathiazole-proflavine compound (containing 1 per cent. Proflavine) was soon abandoned, as “caking” of the powder was often very troublesome and external otitis developed in 40 per cent. of the cases before the ear was finally dry—thus considerably increasing the duration of the treatment. We have, however, recently obtained very encouraging results from the use of two new powders—Sulphathiazole ascorbate and Sodium penicillin-sulphathiazole.

### Sulphathiazole ascorbate

Ruskin<sup>2</sup>, in the United States of America, recorded the results of eight cases of Chronic Suppurative Otitis Media treated by a compound of Sulphathiazole and Vitamin C—six of these by the method of “frosting”. We publish here a table of the results of treatment of eighteen consecutive and unselected cases by this method. The Sulphathiazole ascorbate is an equimolecular mixture of amorphous Sulphathiazole and ascorbic acid, and forms an extremely fine powder. This series, although small, has been very encouraging. The technique employed was the same as with any other powder, and consisted in careful toilet of the ear, followed by “frosting” of the powder. Every patient was seen by us again on the following day and the process repeated daily, if necessary, until the ear was perfectly dry. Thereafter, he was kept under observation once a week for two weeks, once a fortnight for a further month, and once a month until the time of writing (May 24th, 1945). When examined on this date, it was found that all ears thus treated were perfectly dry and in eight the perforation of the drum-head had completely healed. The longest period of observation was 161 days, the shortest 72 days. The powder was used consistently for all cases during the 89 days between the first and the last cases and included several that had failed to respond to treatment with other powders. Table I gives details of these results and will first be explained.

### Physical Examination

The results of our examinations are described under two main headings—(a) The discharge, and (b) The perforation.

#### (a) The Discharge

(i) *The duration* of the discharge is subdivided into present duration and total duration. The first figure is given in days, the second in years (or parts of a year). Hence, in Case I, Sapper J.H.L. had had a

# R. Scott Stevenson and J. Chalmers Ballantyne

discharge from the ear, on and off, for four years, and it had been "running" continuously for 60 days before treatment with Sulphathiazole ascorbate was begun.

(ii) *The amount* of the discharge is assessed by three grades—a single, a double and a triple "plus" sign. The first indicates a moist perforation only, the second a discharge of sufficient amount to obscure a view of the drumhead, and the third sufficient to completely fill the meatus. Three of the cases in this series (Nos. V, VII and XV) belonged to the first category, i.e. moist perforation. The remainder all belonged to the second. Hence, in Case I, Sapper J.H.L. was found on examination to have a moderate amount of discharge sufficient to obscure a view of the drumhead:

## (b) *The Perforation*

The perforation is described under several sub-headings which describe the size, shape, site, position and side of the perforation.

### (i) *The size* is further sub-divided into :

- (S) a small perforation—or one that occupies an area less than half of a single quadrant of the membrana tensa,
- (M) a medium-sized perforation—or one that is larger than the first category but less than the area of an entire quadrant,
- (L) a large perforation—or one that occupies more than the area of one whole quadrant.

### (ii) *The shape* is classed as :

- (R) reniform
  - or (O) oval
  - or (C) circular
- } in the case of central perforations,

and as :

- (H) hemispherical
  - or (L) linear
- } in the case of marginal perforations.

### (iii) *The site* is recorded according to the quadrant it occupies where

(A) is Anterior,

(P) is Posterior,

(S) is Superior,

and (I) is Inferior.

Attic perforations are described separately.

### (iv) *The position* is described as :

(C) central,

or (M) marginal,

and (v) *The side* as :

(L) left,

or (R) right.

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Hence, in Case I, Sapper J.H.L. is found, after cleansing of the meatus, to have a medium-sized, reniform, antero-inferior, central perforation of the right drumhead.

Any complications, such as the presence of granulations or polypi and otitis externa are recorded in the next column.

## Treatment

The treatment is divided into three columns :—

- (a) *Number of applications*—required before the ear was dry.
- (b) *Duration of treatment*—before the ear was dry, and recorded in days.
- (c) *Result*—i.e. whether the ear was dry or moist, and whether the perforation was healed or not on May 24th, 1945.

Hence, in Case I, three applications of the powder were made by the method of "frosting" and the ear was dry when examined 5 days after his initial attendance. No further treatment was given, but the patient was observed as described above and, when finally examined, the ear had remained dry over a period of 161 days and the perforation had healed.

Case II will be described in full (with reference to Table I) as an illustration. Gunner F.B., aged 31, was first referred to the Ear, Nose and Throat Department on December 16th, 1944. The ear had begun to discharge 49 days previously, following a severe cold, and the discharge had been continuous since that time. There was no previous history of aural disease. On examination, there was a moderate amount of discharge, making a view of the drumhead impossible. The external meatus was thoroughly cleaned and a small, oval, inferior, central perforation of the left drumhead was seen. The Sulphathiazole ascorbate powder was blown in gently until a frosted-glass appearance was obtained over the entire drumhead. He returned on the following day and the ear was dry. He was then observed, at first weekly, and later at intervals of a fortnight and finally of a month, until May 24th, 1945, when the ear was found to be still perfectly dry. There had been no recurrence during the 159 days of observation.

Table III summarizes these results and compares them with those obtained by the use of 1 per cent. Iodized boric powder and Sodium penicillin-sulphathiazole powder. An average of two applications over a period of three days (in eighteen cases treated with this powder) produced a dry ear. There were no recurrences and no cases of otitis externa. Eight of the cases (44.4 per cent.) showed a healed perforation when examined finally on May 24th, 1945.

## Sodium Penicillin-Sulphathiazole

Table II shows details of the examination, treatment and results in fourteen consecutive cases of Chronic Suppurative Otitis Media by a new

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TABLE I. SULPHATHIAZOLE-ASCORBATE POWDER

Serial No.	Name	Age	Date of First Attendance	DISCHARGE			PERFORATION			Number of Applications	Duration of Treatment	Discharge	Result (May 24th, 1945)
				Present Duration	Total Duration	Amount	Size	Shape	Site				
1	Sapper J.H.L.	26	14.12.44	49 D.	49	4 Y.	++	M	R	A.I.	C	R	5 D.
2	Gunner F.B.	31	16.12.44	49 D.	49	3/5 Y.	++	M	O	I.P.	C	L	1 D.
3	Sapper J.T.W.	20	19.12.44	21 D.	49	Y.	++	M	O	A.I.	M	L	1 D.
4	Bombardier R.A.C.	26	19.12.44	28 D.	48	Y.	++	M	O	I.P.	C	L	3 D.
5	Aircraftman E.T.	22	19.12.44	3 D.	40	Y.	++	S	O	I.P.	M	L	2 D.
6	L/Aircraftman F.B.	20	21.12.44	5 D.	42	Y.	++	M	L	P.I.	M	R	1 D.
7	Gunner W.W.F.R.	26	21.12.44	90 D.	52	Y.	++	M	R	P.I.	C	M	1 D.
8	Driver F.B.	39	2.1.45	12 D.	4/12	Y.	++	M	H	A.S.	M	L	13 D.
9	Private H.K.	24	9.1.45	3 D.	4	Y.	++	M	R	A.I.	C	M	1 D.
10	Lance-Corporal F.P.	33	2.2.45	7 D.	5	Y.	++	M	L	P.I.	C	R	4 D.
11	Private C.H.J.	38	5.2.45	45 D.	5	2 Y.	++	M	C	P.I.	C	R	1 D.
12	Corporal M.M.D.	43	6.2.45	6 D.	6	Y.	++	M	O	P.I.	C	L	1 D.
13	L/Bombardier T.C.R.	23	6.2.45	14 D.	2/12	Y.	++	S	C	P.I.	C	R	4 D.
14	Craftsman R.E.W.	23	12.2.45	7 D.	12	Y.	++	M	R	P.I.	C	R	1 D.
15	Signaller A.F.	31	12.2.45	5 D.	21	Y.	++	S	C	P.I.	C	R	1 D.
16	Sapper F.J.	24	23.2.45	15 D.	16	Y.	++	M	L	P.I.	C	R	5 D.
17	Private H.O.H.	22	5.3.45	3 D.	2	Y.	++	S	C	P.I.	C	R	1 D.
18	Private M.S.	34	13.3.45	10 D.	26	Y.	++	S	C	P.I.	C	R	1 D.

TABLE II. SODIUM PENICILLIN-SULPHATHIAZOLE POWDER

Serial No.	Name	Age	Date of First Attendance	DISCHARGE			PERFORATION			Number of Applications	Duration of Treatment	Discharge	Result (May 24th, 1945)
				Present Duration	Total Duration	Amount	Size	Shape	Site				
1	Signalman S.G.	23	24.3.45	7 D.	16	Y.	++	M	L	A.I.	N	L	Nil
2	Private H.C.	33	26.3.45	12 D.	20	Y.	++	M	H	I.P.	M	L	Nil
3	Private J.G.	22	29.3.45	3 D.	15 Y.	++	M	C	Attic	P.I.	C	R.L.	Nil
4	Private B.C.	39	5.4.45	56 D.	15	Y.	++	S	C	P.I.	C	R.L.	Nil
5	Aircraftman (r) D.M.	21	6.4.45	68 D.	10	Y.	++	M	L	P.I.	C	R	Nil
6	Driver A.S.	33	6.4.45	35 D.	11	Y.	++	M	R	P.I.	C	M	Nil
7	Private G.M.G.	42	7.4.45	3 D.	4	Y.	++	M	L	P.I.	C	M	Nil
8	Driver R.B.	32	9.4.45	1 D.	2	Y.	++	M	H	P.I.	C	M	Nil
9	Flying Officer J.F.	22	12.4.45	120 D.	10	Y.	++	M	R	A.S.	M	N	Nil
10	L.A.C. A.W.L.	39	14.4.45	30 D.	1/12	Y.	++	M	L	P.I.	C	R	Nil
11	Gunner A.H.C.	44	17.4.45	3 D.	30	Y.	++	M	H	P.I.	C	M	Nil
12	Sergeant B.H.M.	24	17.4.45	10 D.	26	Y.	++	M	R	P.I.	C	R	Nil
13	Corporal W.A.H.	37	19.4.45	5 D.	7	Y.	++	S	C	P.I.	C	R	Nil
14	L.A.C. M.G.B.	23	19.4.45	3 D.	1/12	Y.	++	M	C	P.I.	C	R	Nil

## Treatment of Chronic Suppurative Otitis Media

powder, to which we have so far been unable to find any reference in the literature. The findings are recorded under exactly the same headings as in Table I.

The powder was prepared by adding 3,500 Oxford units of Sodium penicillin powder (supplied sterile by the Pathology Laboratory) to 7 grammes of an amorphous Sulphathiazole powder (already sterilized by autoclaving). The compound powder therefore contained 500 units of Sodium penicillin per gramme of Sulphathiazole.

By comparing these results (in Table III) with those of the previous series, they appear at first sight inferior. An average of  $2\frac{1}{2}$  applications over a period of  $3\frac{1}{2}$  days was necessary before a dry ear was obtained ; there was recurrence in four cases ; and in one of these, the recurrence was complicated by otitis externa (after swimming). The perforation was healed in 28.6 per cent. of cases. The figures, however, can be readily explained by the instability of the Penicillin content, which is well demonstrated in Table II. In all of the first seven cases, a dry ear was obtained by one application of the powder. These have all remained dry until the date of their last examination, and in two cases the perforations have already healed. From this point, there is a sudden rise in both the number of applications and the duration of the treatment. All the recurrences occurred in the second group of seven cases (VIII to XIV). In one it followed swimming, in two it followed an acute coryzal attack, in the last there was no obvious cause. In three of these cases, one further treatment was sufficient to make the ear dry again ; in the fourth (Case IX), a course of zinc ionization was begun.

Sodium penicillin is known to be more hygroscopic than Calcium penicillin and is therefore less stable. The powder was kept in the insufflator at room temperature for only a week at a time and then replenished by a fresh supply from stocks held in a refrigerator. Reference to Table II will show that the stability persisted for a period of only 14 days. We feel, therefore, that better results than we have yet obtained with any powder may be expected from a more stable Penicillin compound, and this has been claimed for a compound of Calcium penicillin and Sulphamezathine (5,000 units per gramme) in a recent A.M.D. Bulletin.<sup>3</sup>

### (B) Wet Methods

"The method of ionization was introduced by Leduc and is based on the principle that by bringing active zinc ions into contact with the bacteria that flourish in, and keep up the aural discharge a solution of zinc sulphate weak enough to be completely non-irritating to the living tissues will act as an effective germicide. Once the bacteria are destroyed, the discharge ceases and the tissues recover."<sup>4</sup>

Many conflicting reports have been published as to the efficacy of treatment of Chronic Suppurative Otitis Media by zinc ionization, but

we record two illustrative cases and feel that they will support our contention that the method is always worthy of trial when dry methods have failed. The technique we employed in these cases was perforce somewhat improvised, as the approved apparatus was not complete. The ear was first mopped clear of all discharge and debris with cotton wool on a Jobson Horne probe. It was then gently syringed with a warm 1 per cent. solution of zinc sulphate at body temperature and the meatus again mopped. A long strip of half-inch ribbon gauze, wrung out in a 1 per cent. solution of the sulphate, was then introduced right down to the drumhead and firmly packed. The electrode was placed on the gauze packing as it presented at the entrance to the meatus, and a current of two milliamperes was used over a period of ten minutes. The treatment was given three times a week.

CASE I.—Flight Sergeant W.R., aged 35, had had an intermittent discharge from both ears for a year and a half. The discharge had been continuous for six weeks when he first reported to us. On examination, there were bilateral, medium-sized, oval, postero-inferior, central perforations. The ears were dry after two months of regular treatment with iodized boric powder but remained dry for only one month. The discharge was successfully arrested after a further two weeks of treatment with the powder, but he had a second recurrence in one more month. A course of ionization was then begun and he received a total of ten applications to each ear. The course was completed three months ago and the ears have remained perfectly dry since that time.

CASE II.—Private R.W.P., aged 39, had first noticed a discharge from both ears eight months before ionization was begun. He had no previous history of aural disease. On examination, there were bilateral, antero-inferior, linear, marginal perforations. He had received regular treatment continuously for eight months with iodized boric powder, but the ears had never completely dried. He was admitted to hospital with a profuse and foul discharge from both ears and a painful eczema of both auricles. A course of ionization was begun shortly after admission and he received a total of 15 applications to the right ears and 12 to the left. The course was completed over four months ago and the ears have remained dry ever since. There has been no recurrence of the skin condition and the drumheads are intact.

### Summary and Conclusions

We have recorded, in this paper, details of the treatment of thirty-two cases of Chronic Suppurative Otitis Media by dry methods, and the results obtained have been summarized in the tables. Sulphathiazole ascorbate has so far yielded the most encouraging results (Tables I and III), but we feel that they may be further improved by a more stable compound of Penicillin with a Sulphonamide.

Two illustrative cases of treatment by zinc ionization have also been recorded, and by a combination of the dry and the wet methods, it has

# Treatment of Chronic Suppurative Otitis Media

been necessary to submit only three patients out of a total of one hundred and ninety-five, to surgical measures.

T. M. Banham<sup>5</sup> records the results of treatment by various powders in 200 consecutive cases, and concludes : " Of the 200 patients treated

TABLE III

Powder	Number of Cases	Number of Applications	Duration of Treatment	Recurrence	Otitis Externa	Perforation Healed
Sulphathiazole Ascorbate {	18 Average :	34 2	52 3	Nil Nil	Nil Nil	8 44.4%
Sodium Penicillin-Sulphathiazole {	14 Average :	34 2½	49 3½	4 28%	1 7%	4 28.6%
Iodized Boric [1%]	30 Average :	119 4	395 13	3 10%	6 20%	No Record

conservatively, I consider that a minimum of 18 . . . required some form of operative treatment." But dry methods only were employed in this series, and even this low figure would seem too high.

Most cases of Chronic Suppurative Otitis Media that respond well to treatment by dry methods respond quickly, and we would suggest that this be abandoned in favour of ionization in any case where there is still an active discharge after one month of regular and careful treatment by powders. Then, and then only, should conservative treatment give way to radical surgery.

In conclusion, we wish to thank Colonel E. P. N. Creagh for permission to publish this paper.

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## CLINICAL RECORD

### RESULTS OF TREATMENT OF CARCINOMA OF THE LARYNX BY X-RAY AT OPERATION

By T. A. WATSON (Liverpool) and VICTOR LAMBERT (Manchester)

IN 1942 the present writers published a description of a method of treat intrinsic carcinoma of the larynx by means of Chaoul "Contact" X-ray. The ala of the thyroid cartilage on the affected side was ablated, a single dose of X-rays was delivered directly to the larynx and the wound then closed.

The whole procedure, which takes about  $1\frac{1}{2}$  hours, was carried out in operating theatre but the patient can be moved to the X-ray Department after exposure of the larynx. The only part of the X-ray apparatus which needs to be sterilised is the metal applicator.

#### Description of Method

The thyroid cartilage on the affected side is approached by a "J"-shaped incision, starting just below the greater cornu of the hyoid bone, the long limb of the "J" being formed by a vertical incision which gradually curves round towards the middle line to the lowest level of the cricoid cartilage. The musculo-cutaneous flap thus outlined is freed in a medial direction until the whole length of the anterior border of the thyroid cartilage is exposed.

The ribbon muscles attached to the thyroid ala are then freed and divided. The perichondrium along the upper border of the thyroid cartilage is then incised and the incision continued down the anterior border of the cartilage and finally along its lower border. This quadrilateral area of perichondrium is then freed from the underlying cartilage (not a difficult matter for anyone familiar with the technique of the sub-mucous resection of the nasal septum as far back as the posterior edge of the cartilage).

A small gutter is then made in the cartilage, parallel with and as close as possible to the junction of the thyroid alae of the two sides. Care should be taken to keep the inner perichondrium intact whilst this is being done. It is now possible to do a sub-perichondrium resection of the thyroid ala on the inner or laryngeal side of the cartilage. The incisions made in the perichondrium in the early stages of the operation now facilitate this manoeuvre. In many cases it is possible to remove the whole of the ala intact.

The operation presents no technical difficulties. From the surgical point of view, the only point is to ensure an adequate exposure at the upper and lower ends of the skin wounds to give an easy introduction of the applicator. The wound is closed with or without drainage. The surgical part of the operation can be completed in half-an-hour if the diathermy is used in haemostasis, as is our custom.

The sterile applicator was placed flat on the exposed surface of the larynx.

\* From Christie Hospital and Holt Radium Institute, Manchester.

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centering over the middle of the affected cord. The applicator used was a circular one 4·5 cm. in diameter, at a focal skin distance of 5 cm. The milliamperage was 5, and the kilovoltage 60. No filters were used, other than the inherent filtration, i.e. 0·2 mm. Nickel.

In the first six cases a metal ring, just larger than the metal applicator, was stitched to the tissues over the proposed field of irradiation.<sup>2</sup> The applicator was then fitted into the ring, thus ensuring accurate and continuous positioning.

The dose given was originally 2,500 r. In later cases this was increased to 3,000 r. In the last four cases of the present series it was decreased to 2,250 r. for reasons which are discussed later.

## Indications for Treatment

Examination of the records of the Christie Hospital and Holt Radium Institute from 1933 to 1935 showed that of 33 cases of intrinsic carcinoma of the larynx treated by the "Finzi Harmer fenestration method", 72 per cent. were free from recurrence five years later, excluding one patient who had died two years after his treatment from intercurrent disease, the larynx remaining well. These excellent results, however, were obtained in selected early cases. The original Finzi Harmer method should be restricted in its application, in that it is suitable only for growths confined to the cord. This X-ray method was therefore introduced with a view to securing a fairly homogenous dose of X-rays over a wider area, covering both ends of the cord. It was used in cases in which the growth was either confined to the cord, or extended beyond the cord at either end, the only proviso being that the growth was confined to the larynx, did not extend across the midline and did not involve cartilage.

## Cases Treated

From 25.3.41 to 27.3.43, 26 cases of carcinoma of the larynx were treated by this method.

The average age of the patients treated was 61 years, the oldest being 81, and the youngest 42. All except one were men. The pathological report in 22 was squamous cell carcinoma, in one adenocarcinoma, in one "malignant tumour", and in two there was no biopsy. The patients in whom no biopsy was made both recurred and are now dead. In 10 cases the left side of the larynx was involved, and in 16 cases the right side. The cord alone was affected in 6 cases, in 4 of these the whole length of the cord being involved. In all the remaining cases (except one where no description is available), the growth extended beyond the true cord, either at one or both ends or into the ventricular or subglottic region. No secondary glands were found in any case before treatment. Four cases developed secondary glands at various periods after treatment and all these patients are now dead.

## After Care

The wound heals by first intention and the patient is discharged from hospital in seven or eight days. There is, of course, no skin reaction, as the skin is not irradiated. There is a moderate reaction inside the larynx, for which no special treatment is indicated.

## Results of Treatment

	All cases, $1\frac{1}{2}$ — $3\frac{1}{2}$ years after treatment	Treatment 3 or more years ago
Number of cases	26	9
Alive and well	13	8
Dead	12	1
Lost sight of (well when last seen)	1	

Only 9 cases were treated three or more years ago.

Of these, 8 are well and free from malignancy, no further treatment having been given, and 1 is dead. The patient who died showed recurrent carcinoma left cord, with subglottic extension.

The voice in all of these 8 cases is serviceable and in 1 case is said to be normal.

The results of the subsequent cases are not so satisfactory even though no essential changes in technique were made.

Of the 12 cases who are dead, 2 died from intercurrent disease 18 months and 3 months respectively after treatment, 1 died 2 months after treatment as the result of a block dissection of the glands of the neck, the primary being well at the time. If these three cases, as well as the case which was lost sight of, are excluded, the figures then are :—

Free from malignancy	....	....	....	13
Dead from recurrence	....	....	....	9
Net total	..	..	..	22

## Discussion

The results of beam directed X-ray therapy in carcinoma of the larynx are irregular and on the whole less satisfactory than would seem probable. On account of the limited size of the larynx it is not possible to limit the high dosage to the part of the larynx affected. If the dosage is of the same order as, for example, that employed in the treatment of carcinoma of the fauces, there is every likelihood of necrosis of cartilage. The dose given, therefore, has to be rather lower than is necessary to produce a satisfactory percentage of cures. When the growth is advanced and involving most of the larynx, there is no choice but to irradiate all the larynx. When, however, the growth is confined to one side of the larynx, it would seem wasteful to irradiate the unaffected side to a high dosage, if this is feasible.

The method which has been described attempts to obviate both the difficulties just mentioned. The cartilage on the affected side is removed. Hence it cannot necrose. The physical factors of the X-rays used are such that the dose received by the affected side of the larynx is high, with a very definite fall towards the unaffected side. It is claimed that this procedure should be capable of dealing with a more extensive growth than the Finzi Harmer fenestration method, since an even dose of radiation is spread over a much wider area.

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In the original choice of dose the only guide available was the treatment of carcinoma of the skin by means of a single exposure of Chaoul X-rays. At that time the skin dose given to superficial skin carcinomas was 2,500 r. surface dose calculated from dose at 1 cm. deep according to Mayneord's<sup>3</sup> figures as described by Meredith.<sup>4</sup> This same dose was, therefore, given to the first two cases of the series which is described. Since the laryngeal reaction was moderate, the dose in subsequent cases was increased to 2,750 r. and then to 3,000 r., the highest dose given. After the lapse of a year it was found that several cases were developing an increased hoarseness and two cases even spat up a small piece of cartilage. This change was temporary, the larynx returning in each case to its former state in the course of four months to a year. These signs were taken as indicative of too high a dose and accordingly the given dose was reduced to 2,250 r. in the last four cases treated. None of these four cases became well and all died of recurrence in from two to ten months. This experience seemed to indicate that the depth dose of the radiation produced by that given dose was not high enough. The maximum depth of the tumour may well be in some cases 1.5 cm. (the distance of the arytenoid cartilage from the lateral wall of the larynx). The depth dose at 1.5 cm., according to Mayneord, with the Chaoul tube and circular applicator 4.5 cm. diameter is 56 per cent. Thus, if the surface dose is 2,250 r., the dose at 1.5 cm. is 1,260 r. This is inadequate.

For these reasons the Chaoul X-ray tube was abandoned for this method and replaced by a tube working at 140 kv., 5 ma., 1 mm. Al filtration, 15 cm. f.s.d. The applicator used was again a sterilizable circular metal one 5 cm. diameter. The surface dose chosen was 2,000 r. With these factors, the dose at 1.5 cm. is 1,400 r. Eight cases were treated by this method from 9.9.43 to 17.2.44. Of these cases, five are now free from malignancy, one is recurrent, one died 2½ months after treatment, there being no record of the condition of his larynx, and one died the same night as the treatment, as a result of the anaesthetic. These cases are still too recent to permit deductions but it would seem as if a higher dose could be easily tolerated.

## Conclusion

In light of results it would seem that the method described is worthy of further trial but that the physical factors of the X-rays should be adjusted to produce a higher depth dose.

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- <sup>4</sup> MEREDITH, 1940, *Brit. J. Radiol.*, September, xiii, 153.

SOCIETIES' PROCEEDINGS  
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*President*—L. GRAHAM BROWN, F.R.C.S.

**Conclusions Based on Twenty-Five Years'  
Practice in Mastoid Surgery**

**PRESIDENT'S ADDRESS**

By L. GRAHAM BROWN, F.R.C.S.

To attempt a review of mastoid surgery during the past quarter of a century would be beyond the scope of this Address. It may prove useful if I express some thoughts upon the subject of mastoid surgery which are the outcome of my own experience.

I believe the opportunities for mastoid surgery are gradually decreasing in proportion as the prophylactic measures against the incidence and spread of aural disease increase. Indeed the time may not be far distant when intracranial complications of otitic origin will be considered rare phenomena.

During my apprenticeship I can well remember having been greatly shocked by the gross infection occurring in post-operative mastoid wounds. It was a time when the method of packing the open wound was still in vogue. There resulted too many failures in the form of chronic middle-ear suppuration, post-auricular fistulae or unsightly scars and depressions. Even keloids of the scar tissue were not uncommon. Mollison (1937) has recorded the advance in theory and practice which has helped in bringing about the better results to-day. This improvement has been obtained mainly by three important factors, viz. the position of the skin incision, the technique of operation upon the soft tissues and diseased bone, and the post-operative care of the wound.

The essential points are: The skin incision, instead of being in or near the post-auricular sulcus, should curve widely outwards, even to the hair-line, and thus provide a large anterior skin-flap which on replacement will entirely cover the bony cavity. There should be as little interference as possible with the soft tissues. That is to say, the temporal muscle should not be incised, whilst the periosteum should be dealt with by a T-shaped incision and carefully preserved by elevating it from the small area of bony cortex which later has to be removed. There should be little if any interference with the attachment of the sterno-cleido-mastoid muscle to the mastoid process, and the latter, likewise, should be preserved as far as possible. There should be a thorough removal of all diseased bony and cellular structures by means of gouge and curette, whilst the cavity remaining should be smooth and shelving. The

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wound should be completely closed except to provide drainage at the lower end by means of a small rubber tube. Finally, meticulous post-operative attention should be given to the wound. The latter, if it cannot be undertaken by the surgeon himself, should be left only to a carefully trained assistant, preferably, in hospital, the ward-Sister.

Syringing the wound cavity and the external auditory meatus is an infinitely better method of cleansing the ear than swabbing with pieces of cotton-wool. The latter can be not only a painful procedure but can cause delay in healing owing to irritation of the repair granulation tissue. To help to get rid of the initial infection, and to prevent reinfection of the wound and middle-ear cavity, I strongly advocate the use of 50 to 60 per cent. of S.V.R. applied on a strip of  $\frac{1}{4}$  in. ribbon gauze. Following these essentials, the average time of complete closure of the wound and healing of the tympanic membrane should be no more than twelve days. From time to time there have been advocates for the complete closure of the mastoid wound at the time of operation; recently the advent of the sulphonamides and their use in powdered form may bring about this desired gain.

For the radical mastoidectomy the same essentials should apply, except that the posterior wound can be completely closed, drainage being provided for through a flap in the external auditory canal. Here arises a debatable point. To what extent should a plastic flap be cut in the meatal wall? I have long been an advocate of using the smallest one possible. Unlike Körner, Panse, Ballance and others, I never invade the cartilaginous portion. Such a procedure should be reserved only for cases of cicatricial stenosis of the canal, very often the results of previous bad surgery. I content myself with a small tongue-shaped flap which is really the extremity of the posterior membranous portion. Such a small flap tends to decrease the eventual size of the healed cavity and later on makes its periodical cleansing comparatively easy.

In the performance of the radical operation I believe that it always pays to attempt to close the Eustachian tube by careful curetting of its lining mucosa as far down as the isthmus. When successful, this must prove an important factor in attaining complete epithelialization of the cavity. Further, one should not forget that suppuration persisting from a radical mastoid cavity may be due to the presence of a fistulous tract from the petrous bone. Hence, during the operation careful inspection should be made to exclude such a possibility.

Where the amount of hearing present is useful to the patient, the radical mastoid operation is to be avoided whenever possible, particularly in children and young adults. The incomplete, or modified, or conservative radical mastoid operation was first described in this country by Heath in 1904. It aimed at conserving the function of hearing as much as possible, whilst eradicating the potential danger of a chronic suppurative disease. It consisted in opening up the attic and mastoid bony regions, removing diseased tissue but retaining healthy ossicles and as much of the tympanic membrane as remained.

Various modifications of this operation have been described by Cottle (1933), Lempert, Jenkins and others. However, the one that has found most favour with me is that described by Sourdille for another purpose, viz. the first step in his multiple operation on the mastoid prior to fenestration of the

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external semicircular canal in cases of chronic progressive deafness and otosclerosis. I have performed many operations of this kind, closely following his technique. It should be done only in very carefully selected cases, in which the hearing is good and the perforation is in the attic region or is small and marginal in the posterior segment of the tympanic membrane. The presence of cholesteatoma need not always prove a contra-indication to the operation. Regarding the ossicles I have come to the conclusion that unless covered by healthy mucous membrane, the incus and head of the malleus may as well be removed. If left, even though not necrosed, they later on become involved in the healing process. The fibrous tissue eventually binds them down and renders them immobile, thus from pressure effects making the final degree of hearing less than if they had been removed at operation. One admits that removal of the incus and head of the malleus (the latter to facilitate drainage only) invariably reduces the acuity of hearing. Nevertheless useful hearing is maintained. To my mind, the question of the conservation or not of the ossicles is of far less importance than the problem of how to maintain the mobility of the oval and round windows. If, as I believe, good hearing depends on the proper functioning of these windows, the one being in opposite phase and synchronous with the other, this, maybe, can only be achieved by an operation which leaves an air-space in the tympanic cavity, with the walls of the latter covered over by mucous membrane. Hence my contention that it is better to remove the incus at operation rather than, by retaining it, find it later on bound down by fibrous tissue and exerting a pressure effect upon the oval window *via* the stapes. This theory, too, can explain why, after the radical mastoid operation when the cavity remains moist, hearing is very often much better than in the completely epithelialized one. The continuity of the external auditory canal membrane with that of the tympanic membrane should be preserved, and drainage should be carried out *via* the post-auricular incision as in simple mastoidectomy. W. McKenzie (1940) published his results of 70 cases operated upon by the conservative radical method. My own results are about the same as his, viz. about 50 per cent. of dry ears with retention of good hearing. My technique, however, differs in that I have never yet made use of a meatal flap.

Since the field is so small and the technique both difficult and delicate, the surgeon is greatly facilitated in his work by the aid of binocular magnifying spectacles, good lighting and an efficient blood-suction apparatus. The same applies, of course, to other regions of mastoid surgery, but especially to that to the inner wall of the middle-ear cavity where magnification helps one to recognize important small relations and to carry out the necessary delicate instrumentation.

Otologists have often discussed the significance that lies in accidentally or purposely uncovering the dura mater and the lateral sinus in cases of otherwise uncomplicated mastoiditis. I believe the answer is this: Never purposely lay bare these structures unless the bony disease leads down to them, but, when thus removed or accidentally so, bear in mind the fact that infection has been brought a stage nearer to the vital intracranial contents, and govern your subsequent proceedings accordingly. It is advisable to leave such a wound well exposed and very lightly covered with sterile gauze, rather than

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to close it up with possibly infected blood-clot. Penetrating wounds of the dura and sinus wall should be dealt with in a similar manner, though it may be necessary sometimes to occlude a grossly injured sinus above and below the site of injury and open up the intervening portion. Through neglect of these precautions one has seen not only rapid infection of the meninges but also fatal haemorrhage from the subsequently infected lateral sinus.

Following the modern technique, skin and muscle grafts on the mastoid cavity should seldom be necessary after an uncomplicated simple or radical mastoidectomy. In plastic operations to close large post-auricular fistulae, or to open up a stenosed external auditory meatus which is inadequately draining a suppuration from the middle ear, they may occasionally be used with advantage.

The respective merits of the post-auricular approach as compared with that of the endaural route, as advocated by Lempert (1928), has been well discussed by many aurists and the superiority of the latter method has not been substantiated. The fact that the majority of otologists still practise the old and original method is sufficient answer to the question. Indeed, a tolerant attitude becomes sceptical criticism when Lempert further advocates this approach for such operations as fenestration of the external semicircular canal for otosclerosis and those concerned with the various intracranial complications spreading from the middle ear and mastoid.

Injury to the facial nerve during the course of a radical mastoid operation is a distressing event both to the patient and to the surgeon. Although the utmost care may be exercised in clearing out the middle-ear cavity, a paralysis of the nerve may occur even though it be discovered only post-operatively. Especially one should be on the look-out for this in cases of cholesteatoma when dehiscences in the bony wall of the fallopian canal from erosion are so likely to occur. Fortunately, a fair proportion of these paralyses eventually recover, especially the post-operative ones. However, those that do not must remain an everlasting stigma or undergo attempts for their repair by one of the several methods of graft implantation or anastomosis with other cranial nerves. Even plastic surgery on the facial structures themselves, as practised by Gillies, may have to be tried. A full review of the methods employed for the surgical treatment of traumatic facial paralysis by direct nerve suture and graft inlay has been given by Miss D. J. Collier *et al.* (1941). Following the pioneer work of such men as Ballance, Duel and Young, future workers can and will obtain much better results.

The treatment of petrositis, associated or not with Gradenigo's syndrome, still presents a problem to the otologist. The diagnosis is undoubtedly helped by radiography, especially when the cranial nerves in relation to the apex of the petrous and to the posterior fossa show no clear evidence of irritation. The surgical treatment has been thoroughly reviewed by Ramadier, Watkyn-Thomas (1936), Kopetzky (1933) and others, and each has advocated his own preferred method of approach to the cellular apex. It seems to me that one should adopt as conservative a method as possible. Very often a simple cortical mastoidectomy suffices to clear up the symptoms of an acute petrositis, just as the radical operation following an acute exacerbation of a chronic middle-ear suppuration will do likewise. When, however, often after a latent

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period, the clinical signs and symptoms suggest an empyema of the petrous apex—usually readily confirmed by radiograph—further steps should be taken. The fistulous tract should be carefully sought for, and when found to be present in the region of the antrum or semicircular canals, its opening should be enlarged and the tract curetted right along its path until the pus is reached and can be evacuated. When the opening of the fistulous tract cannot be found, or it is in the region of the Eustachian tube opening, the route chosen should be behind the arch of the superior vertical canal in relation to the postero-superior surface of the pyramid. The approach *via* the tubal cellular tracts and carotid canal, as recommended and practised by Ramadier, is condemned by Kopetzky as being far too difficult and hazardous.

Again, conservatism should be our attitude in surgical treatment of inflammatory disease affecting or invading the labyrinth. Our first duty should be to clear away the primary focus, whether this means simply incising a drum-head or performing a simple or radical mastoidectomy. Only if and when symptoms of meningeal irritation occur should we proceed further to the opening up of the labyrinth, preferably by the method of Neumann.

Perisinus abscess and extradural abscess are complications of mastoid disease which are admittedly difficult to diagnose before operation. As a rule they need not exercise our minds very much provided that at operation we do not disturb any granulations present, for these are Nature's barrier of defence against bacterial invasion. The wound should be kept well open and the patient carefully watched for further spread of infection to intracranial contents.

Before passing on to a consideration of the most serious of the endocranial complications of otitic origin, viz. meningitis, brain abscess and lateral sinus thrombosis, it may be useful here to mention the use of sulphonamide therapy and that of penicillin. Before the introduction of these powerful, selective, bacteriostatic drugs the prognosis in such cases was always considered grave. This led in turn to elaborate surgical methods of treatment which, in already enfeebled patients, and particularly in cases of acute diffuse suppurative meningitis, very often did nothing more than quicken or delay the fatal issue.

The sulphonamides, since their introduction about the year 1937, have already proved their worth and have decidedly altered our conceptions of how to deal surgically with these conditions. Likewise it seems probable that penicillin, after further trial, will do the same. Briefly stated, their value is as follows : These drugs will not by themselves, and unaided, cure infective disease produced by certain organisms, except perhaps in the earliest stage of invasion. When pus has begun to form in bone or soft tissues the inflammatory process may be retarded, with the so-called masking of symptoms, but not to the point where resolution can effect a healing of such abscesses. Cirillo (1942) has cited several cases which ended fatally owing to the too early use of this form of chemotherapy and the consequent masking of symptoms. Most of us have had similar experiences, and we have been taught that these drugs cannot replace surgical treatment if an undrained necrotic focus is present. The great increase (almost double) in the recovery rate since the introduction of chemotherapy has been clearly shown by Williams and others (1942) in their review of the literature on otitic meningitis and report of results five years before and since the introduction of chemotherapy. However,

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apart from this added use of the sulphonamides, their conclusions as to the best method of treatment do not materially differ from those arrived at in a discussion on the subject by Layton, N. Jory and Symonds (1934).

I lay great stress on the diagnostic value of lumbar puncture and examination of the cerebrospinal fluid in all cases of suspected endocranial infection. Increase in pressure above normal levels and an abnormal cytology of the fluid, in conjunction with ordinary clinical signs, nearly always give a positive indication that the vital structures of the endocranum are being attacked. If the focal area of infection has not already been removed by operation, this procedure should no longer be delayed. If, on the other hand, only after the initial operation has this evidence been gained, further operative measures, and certainly chemotherapy, must be introduced without delay. It must be remembered, too, that the proper concentration of these drugs is most important and can only be determined by a blood examination. Again, the prognostic value of lumbar punctures will keep us informed of the efficacy or not of our therapeutic measures.

Brain abscess, whether it be in the temporosphenoidal lobe or the cerebellum, is a matter of great concern both to the otologist as well as the neurosurgeon. I think that, as far as brain surgery is concerned, we otologists should recognize our limitations. Personally, from a review of my own cases of otitic brain abscess, I have found that I have been successful only when I have discovered the fistulous or necrotic tract leading to the brain tissue and through this, with a minimal disturbance of adherent meninges, have been able to locate the pus and establish drainage into the abscess cavity. The neurosurgeon on the other hand has established for himself rules of procedure for dealing with the abscess, whether by decompression, aspiration or enucleation, or by a combination of some or all of these. Northfield (1942), in some recent publications, gives a full account of these procedures and shows how, influenced by the closed method of treatment of brain abscess by Clovis Vincent, neurosurgeons to-day are obtaining increasingly better results.

There is still considerable difference of opinion among otologists regarding the best method of treatment for lateral sinus infection. Controversial problems arise concerning the eradication of the septic clot in the sinus itself or its extension to the jugular bulb, or even beyond this to the internal jugular vein. There are conflicting opinions, too, about whether to resect the whole or a portion of the vein in the neck, to ligate it (i.e. sever it between ligatures), or whether to leave it severely alone. I will state briefly my views in the light of my own practical experience. The simple, modified or complete radical mastoidectomy should first be completed. The lateral sinus is then laid bare, particular attention being paid to the upper end by nibbling away the bony groove until healthy sinus wall has been reached. The vein at this upper end is then temporarily plugged. The lower end is dealt with similarly, but if healthy vein has not been reached one stops short of the jugular bulb. A gauze plug is introduced here and the sinus is then opened and whatever blood clot it contains is turned out. As much of the outer wall is removed as possible. Tentatively, the upper plug is now released until one feels assured free bleeding has occurred, after which the plug is firmly replaced. The lower end is dealt with in a similar manner, but if no bleeding occurs the plug is

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dispensed with altogether. Bleeding sometimes occurs from the inferior petrosal sinus or the mastoid emissary vein, in which case light packing with gauze will suffice to control it. The wound is left well open and only lightly dressed with sterile gauze. I make a point of removing the plugs from the sinus at the earliest possible time, sometimes on the second or third day.

We come now to the question of the internal jugular vein. I confess I have never tied one in the past fifteen years, nor have I ever opened up the jugular bulb area. I was influenced towards this conduct by the fact that some twenty years ago I saw my chief, Mr. Norman Patterson, searching for the internal jugular vein in order to ligate it. Finding it thrombosed beyond the clavicle, he left it alone and the patient made a complete recovery. This led me to several conclusions which, rightly or wrongly, have guided my actions ever since. First, I believe that in a thrombosed sinus an aseptic clot always precedes the infected portion. Secondly, if one opens the sinus where the initial infection has occurred drainage is thereby established, the *vis a tergo* is removed and little if any further aseptic thrombosis takes place downwards towards the heart. Thirdly, the induration about the upper part of the internal jugular vein is mainly caused by the lymphatics draining the sinus and jugular bulb area, including that of the mastoid bony tip. This infection may often lead to abscess-formation deep in the muscular layers of the neck which will need to be opened by incisions in front of or behind the sternomastoid. Chemotherapy by the sulphonamides will play an important rôle nowadays in dealing with the toxæmia or blood infection. My record of cases in the past fifteen years of practice at one hospital shows 19 recoveries out of a total of 23. I may have been merely lucky, or else, perhaps, there is something in what I say about it being unnecessary to tie the jugular. It is interesting to note that Singleton (1942) has recently recorded the recovery of six consecutive cases of this disease in which the vein was not ligated, and he too now questions the necessity of doing so. I believe that when rigors occur early in cases of lateral sinus thrombosis before operation is undertaken, they do so whilst the thrombus is forming, when toxins, infective emboli or even isolated organisms may be entering the blood-stream. After thrombosis is complete toxæmia may still produce rigors, but emboli and organisms are excluded from the blood-stream. Metastatic abscesses in the lungs, joints and other regions of the body may occur after operation, but I think they are the expression of the earlier septic emboli which have got through the vein before complete thrombosis has occurred. Hence to prevent these, it would be too late to tie the jugular if at operation we have cleared out the infected clot completely or have left behind a thrombosed vein in the lower portion.

Suitable operations on the mastoid for the relief of tinnitus, vertigo and deafness have exercised the minds of otologists ever since mastoid surgery began. However, in the last twenty years or so, along with our advance in the theories of equilibrium and hearing, these have been mainly directed towards operations on some part of the labyrinthine capsule. In Ménière's syndrome complex when the membranous labyrinth itself is considered to be at fault and other factors have been excluded, a variety of operations have been advocated and practised. Since we do not yet fully understand the aetiology or pathology of the condition, although Hallpike and Cairns (1938)

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have so far given the best explanation, we cannot hope to be completely successful in our operative procedures. Portmann's operation on the saccus endolymphaticus, Dandy (1941) and other neurosurgeons' section of the VIIth nerve, Wright's injection of alcohol into the vestibule *via* the tympanic membrane and the oval window, Mollison's injection of alcohol into the exposed external semicircular canal and Cawthorne's modification of this without alcohol injection, have all given fairly good results. My own feeling in the matter is that medical treatment on the lines recommended by Tobey (1941), Dederding, Mygind, Furstenberg and others will continue to suffice for the majority of sufferers, but if and when an operation must be performed, Wright's method should first be tried, but if unsuccessful, fistulization of the external semicircular canal *via* the mastoid approach should be recommended.

For the alleviation of deafness of the chronic progressive conduction type much experimental work on the labyrinthine capsule has been done by Holmgren, Sourdille, Lempert and others. This has been well reviewed by Kopetzky (1941), who presents the difficulties, apart from the delicate surgery involved, in obtaining lasting beneficial results. The external semicircular canal seems to be the site of election for the fenestration. No method, however, has yet been devised for ensuring the patency of this artificial window, or rather its mobility. Sooner or later it becomes fixed, either by fibrous tissue or by the osteogenesis that takes place there. This, in my opinion, is the same problem that confronts us in the case of the modified radical mastoid operation, viz. how to ensure the mobility and hence the reciprocal action of two membranous windows, whether they are those provided by Nature or artificially provided by us. Until this problem can be solved it seems to me that we will not progress much further in helping to alleviate this type of deafness. In the meantime increasing help can doubtless be expected from the rapidly improving electrical aids for hearing by bone conduction.

In conclusion I shall merely mention some rare diseases that demand mastoid surgery. A gumma of the mastoid I have never seen, and tuberculosis only on a few occasions, in one of which, however, the whole of the petrous bone showed itself at operation to be a complete sequestrum. A dead labyrinth and a facial nerve paralysis were attendant factors. Again, I have seen during the past six years two cases, confirmed by operation, of a rare pathological condition, viz. haemangioma of the petrous bone invading the middle-ear cavity and the posterior fossa of the skull. In the one case I was associated with Mr. Mollison and with him performed a modified radical operation. The case was then taken over by Mr. Northfield, who attempted the removal of the growth from the posterior fossa and petrous bone. A course of deep X-ray therapy followed operation with apparently satisfactory results. The other similar case was dealt with in conjunction with my surgical colleague, Mr. Broster, but has since been lost sight of. With regard to cases of cavernous sinus thrombosis I have only seen one in the whole of my career, and that ended fatally.

The occasional malignant disease of the ear and mastoid can still only be dealt with palliatively by a combination of surgery, diathermy and X-rays.

In conclusion may I add that I hope I have raised in this Address some useful points for discussion, from which, too, there will arise a consensus of

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opinion that will serve to help us when dealing with future problems of mastoid surgery.

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Mr. W. M. MOLLISON : *Choice of operation* in chronic suppurative otitis. In young people I feel that the radical should not be done on account of the loss of hearing after it and in view of the powers of recovery of function in the young. Unless the malleus and incus are found necrosed some form of conservative operation should be followed, only proceeding to the radical if conditions finally necessitate it. One of the essentials for success is a generous meatus and the President has stressed this by his treatment of the deep free end of the soft tissues; in many cases a temporal muscle flap is helpful. Incidentally this temporal flap is the only method of closing post-aural fistulae with 100 per cent. success.

These two tables show the hearing after various operations; they are the result of the examination of recruits referred from medical boards and show the results of the operations. Hearing is *good* if the man heard 10 ft. and upwards, *bad* if he heard 0 to 6 in. and *fair* in between.

TABLE I.—186 MEN, AGED 17-25

Radical operation	..	..	..	..	10 (dry 4)
Hearing bad	..	..	..	..	9
Hearing fair	..	..	..	..	1 (facial paralysis 1)
Conservative operation	..	..	..	..	17 (dry 6)
Hearing good	..	..	..	..	4
Hearing fair	..	..	..	..	7
Hearing bad	..	..	..	..	6
Heath's operation	..	..	..	..	1
Hearing poor	..	..	..	..	1
Simple operation	..	..	..	..	14
Hearing good	..	..	..	..	9
Hearing fair	..	..	..	..	1
Hearing bad	..	..	..	..	4

$$42 = 22.5\%$$

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TABLE II.—205 MEN, AGED 25-42

Radical operation	..	..	..	..	9 (dry 5) 8 (1 not known)
Hearing bad	..	..	..	..	
Conservative operation	..	..	..	..	7 (dry 0) 7
Hearing bad	..	..	..	..	
Simple operation	..	..	..	..	8 (dry 4) .. 24 operations (dry 9)
Hearing good	..	..	..	..	9
Hearing bad	..	..	..	..	4
Hearing fair	..	..	..	..	1
Permeatal operation	..	..	..	..	1
Hearing bad	..	..	..	..	1
					<hr/> <u>25 = 12.2%</u>

A recital of possible mishaps during operation on the mastoid may be encouraging as showing what Nature can do in the way of recovery.

(a) Opening the mastoid under the impression that there is a posterior marginal perforation with granulations and pus, only to find the mastoid normal and the granulations due to local necrosis of the tympanic ring—always annoying.

(b) Letting the gouge slip in the wrong place; on one occasion my gouge slipped and punctured the dura above the tegmen antri, while operating on an acute mastoiditis. The operation was completed. The temperature and pulse charts were watched: in three or four days the temperature became subnormal and the pulse slowed and the patient vomited. The wound was then opened and a subdural abscess evacuated and uninterrupted recovery followed.

(c) Puncture of the lateral sinus during operation for acute mastoiditis; a child developed signs and symptoms of thrombosis in a few days; the internal jugular was ligatured and the patient recovered.

(d) Damage to the facial nerve; an elementary knowledge of the anatomy of the position of the nerve should save it from damage and indeed it is rare to see a paralysis in these days. However, I have damaged it on three occasions (this is as far as my memory takes me) and in all three it was in cases of very brittle and hard bone: (1) In operating for acute mastoiditis, opening the cells running down immediately posterior to the nerve in its canal, the bone cracked across the canal and facial paralysis resulted and I fear was permanent. (2) During a radical operation—the same accident, but in this case recovery occurred in a few weeks. (3) In an operation to open the external canal, the bone was seen to crack—it was pressed back into position—the operation of opening the canal was completed. The resulting paralysis had completely disappeared in three weeks.

Mr. F. W. WATKYN-THOMAS said that Mr. Mollison's rubber-dam technique was most valuable; it made dressings as nearly painless as mastoid dressing could be.

The epitympano-mastoid operation without plastic flap was introduced by Bárány about twenty years ago, and was widely used for some time in the Northern European clinics. He had done a number himself, but he had found that, in spite of some excellent results, too often a secondary plastic was needed to provide drainage. This was a general experience: Jessen of

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Copenhagen found that in 71 cases of this operation there was complete healing in only 58 per cent. of cases, and in eight years S. H. Mygind found that of 31 cases of mastoids requiring further operation 22 had been treated by this method. He felt that the President's excellent results were due to the skill of the operator, not to the propriety of the operation. He agreed that preservation of the ossicular chain was not the most important factor in the preservation of hearing. The important thing was to leave enough of the drum to protect the inner wall. So far as hearing was concerned it did not matter materially whether the incus was removed or not. If an incus was so loose that it would come out at a touch of the hook it was clear that the continuity of the ossicular chain was broken already, and the incus should be removed as a useless foreign body.

In the last 12 cases of lateral sinus thrombosis which he had seen 8 bled freely from both ends when the sinus was opened, and no interference with the jugular was needed. In one, the only fatal case, there was no bleeding from the upper end; the patient died of a cerebral thrombophlebitis. In 3 there was no bleeding from the lower end. One patient recovered without further trouble. In 2 swinging temperatures continued and the vein was tied. Both patients recovered. Perhaps they would have recovered anyhow, but they did not look as if they would.

When he ligated the jugular he always preferred to divide it, bring the upper end to the surface, and tie all branches above the point of section.

Mr. T. B. LAYTON said that during the last twenty-five years otologists had learnt to be conservative when treating mastoid cases.

He did not believe to-day that the simple incision for the post-aural swelling should ever be done until pus had formed which could be felt by fluctuation. It was surprising when this plan was adhered to how many recovered without any operation at all. The only exceptions to this rule should be when rigidity of the neck, indicating meningeal irritation, was present, or where a rigor had occurred, suggesting sinus invasion: and both these were very rare in cases with a retro-aural swelling. A snick should be made and a tube put in for forty-eight hours. He now believed that no mastoid operation should be performed on a patient with a retro-aural swelling until pus had formed and that snick had been made.

They had also learnt that chronic ear disease was an incurable condition. Ear disease had to be tackled from an earlier stage than at present. In the population it was to-day dealt with from the schools. That was too late. It had to be dealt with before the child got back to the school after the acute ear disease had occurred.

Mr. E. COWPER TAMPLIN said that for three years now, with the aid of sulphathiazole insufflated at operation, he was discharging about 80 per cent. of cases of acute mastoid in eight days, soundly healed with a dry middle ear. It was doubtful if this could be further reduced with penicillin.

Mr. I. SIMSON HALL said that in chemotherapy a weapon had been found so effective against the serious complications of otitis media that the possibility of a fatal termination was slender, and all our skill could now be directed towards the preservation of function in the ear affected.

Those whose duty it had been to examine recruits for the Forces had been

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impressed by the wastage of otherwise high-grade man-power owing to the results of otitis media.

The large number of low-category men and women was convincing proof that it was time the treatment of otitis media was replanned with restoration of function as the criterion of success.

Mr. TERENCE CAWTHORNE made a plea for abandoning the term "conservative-radical" operation in favour of "modified", adding if necessary a descriptive but *not* contradictory adjective.

For the past six years he had used the endaural approach for the uncomplicated radical operation where the mastoid was acellular. He had found that with practice this approach offered certain advantages over the formal operation.

To avoid exposure of the dura of the middle fossa, he recalled Arthur Cheatle's advice on the subject of what to do when in doubt as to the whereabouts of the mastoid antrum: "Remove the tegmen and follow the dura inwards. You will always find the antrum without jeopardizing the labyrinth or facial nerve." His experience of facial nerve surgery had been that often the nerve had been damaged in the course of a mastoid operation because the operator had tried to search for the antrum too far down. Whilst it was clearly not necessary to expose the dura in every case, its value as a landmark and guide should be remembered and taught.

Bleeding from a lateral sinus accidentally injured could usually be checked by the application of a small square of temporal muscle. The advantage of this over plugging was that the lumen of the sinus was not encroached upon.

The work of Hallpike and Cairns, Wright, Crowe, Rollin and Fowler had established a pathological basis of sufficient stability to warrant the use of the term "Ménière's disease" in many cases of vertigo and deafness, and he hoped that the terms "symptom complex" and "syndrome" as applied to Ménière might be abandoned.

Brigadier MYLES L. FORMBY said that it was the skill with which the atticotympanotomy was performed and the subsequent meticulous care with which the President always personally treated his cases that were the important factors. It was useless to do the operation and leave the after-care to somebody else, suppuration invariably continued and although the ear might no longer be dangerous the result would certainly not be satisfactory.

Concerning the drainage of brain abscesses he agreed that where the track was obvious, the dura necrotic and the abscess at or near the brain surface in relation to the mastoid wound, it should be opened and drained. For all other cases the correct procedure was repeated aspiration through healthy dura. If the dura exposed in the wound were thoroughly cleansed then exploring the temporosphenoidal lobe was not a dangerous procedure. Success in the treatment of brain abscess depended on resistance to the spread of infection by the surrounding brain tissue and removal of the pus. The latter could not be achieved by drainage, at any rate not for any length of time, except in a few abscesses that were very near the surface.

Mr. R. D. OWEN said he would like to know whether the President still regarded mastoid drainage, in childhood, as the right or the wrong thing to

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do where the case presented normal temperature and no mastoid tenderness but a pulsating discharge persisting for five or six weeks after the initial onset.

Although one might rely on sulphonamides for resolution and an intact drum, one must not forget that these cases of subacute mastoiditis if left without drainage could lead to permanent deafness. It was quite likely that a good number present themselves in middle age with progressive deafness associated with Ménière's disease. He felt that a timely paracentesis or mastoid drainage would avoid this disability in adult life.

The PRESIDENT (in reply) said that he dispensed with the meatal flap as far as possible, for he looked upon the external auditory meatus as a by no means unimportant structure for the hearing function.

For drainage after a single mastoidectomy he used a fine rubber tube containing a wick of narrow ribbon gauze which was left in place for forty-eight hours in order to form a channel down to the antrum for further drainage with a gauze wick only. From many years' experience he found alcohol (50 per cent.) an excellent bactericide and since using it as a routine had seldom been troubled by secondary infection of the wound. He certainly agreed that there was an increasing tendency to close the wound at the time of operation.

Preservation of hearing was a very important factor in mastoid surgery, and in this respect the conservative mastoid operation had proved its value. The removal of the incus meant usually no more than a loss of acuity in hearing. If there was more than this loss of acuity one must look elsewhere for the impairment, for example, in the round or oval window or in the nerve itself.

Exposure of the dura should always be considered as a potential danger of infection to the intracranial contents and treated accordingly.

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## SOME IMPRESSIONS OF OTO-RHINO-LARYNGOLOGY IN GERMANY TO-DAY

By BRIGADIER W. I. DAGGETT (London)

### Introduction

RECENTLY it has been my privilege to be included in a medical team which was sent to Southern Germany in order to assess the value of any recent advances which have been made in the different branches of medicine and surgery. The tour was officially sponsored so that every opportunity was afforded us to see what was being done, and to discuss the trend of progress with those best qualified to express an opinion.

Because, in the past, Germany has been in the forefront of progress in Oto-rhino-laryngology, and because little or nothing has been heard of the work in that country for six years, it occurred to me that a brief description of my impressions might be of interest. I have no intention of expressing views concerning the effect of political control upon medical schools, though the results of such control were unpleasantly obvious.

Our visit was made soon enough after the cessation of hostilities to coincide with the suspension of teaching; this unfortunately resulted in inability to learn much about the handling of students.

### Itinerary

The tour was confined to the American and French zones of occupation and therefore only the following places were visited:—

- (1) Heidelberg, where the Director was Professor Seiffert, who had recently moved from Kiel to take charge.
- (2) Tübingen, where Professor Weber Albrecht was Director.

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- (3) Freiburg where University and E.N.T. Clinic is totally destroyed. There Professor Kahler is having to face the problems of starting from the beginning with little equipment and no specimens.
- (4) Innsbruck, which was found to be struggling under an additional handicap of reorganizing its clinic subsequent to a medico-political " purge ". The Professor designate was Dr. Höbst.
- (5) Erlangen, where the Professor (an S.S. man) had been recently superseded by Dr. Helmuth Richter.

Other places, unimportant from the E.N.T. standpoint, were visited because there were many investigations to be made by other members of the team. At Garmisch Partenkirchen an American Evacuation Hospital commanded by Colonel Thom was of great interest. This hospital was housed in a large building which had been equipped and used as a Lazarette by the Germans. Much good quality equipment had been left behind and the E.N.T. department was very impressive.

## General Remarks concerning German E.N.T. Clinics

It has been customary in Germany for many years to plan entirely self-contained clinics in which all steps in diagnosis can be taken without referring patients to outside departments. Pathological investigations can be made, X-rays taken, and all forms of treatment carried out. There is inherent in this system one big advantage, namely, that there is no overburdening with routine work, and all those working in the different branches of the specialty have ample time for research. The professor is, without question, the " Führer ", but until the Nazi leaders insisted on professors prostituting their influence to serve political aims, no harm resulted.

No expense has ever been spared in organizing clinics for teaching purposes, moreover, it is inconceivable that students could ever sit for their final examinations without having attended the set course and having learned the theory of oto-rhino-laryngology. This cannot always be said about our own E.N.T. teaching which allows too much licence for non-attendance. In Germany, the professor and his assistants have time to teach, they are never weighed down by the knowledge that there are scores of routine " return cases " to be dealt with when their demonstration is finished. Pre-graduate teaching is much more theoretical and less practical than our own.

It has already been pointed out that, at the time of our visit, the teaching of medical students had been temporarily suspended; it was therefore not possible to observe demonstrations in progress. Despite this, it was quite evident that greater facilities for systematic teaching were provided in those places visited (except Freiburg) than in comparable clinics in the United Kingdom.

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## The General Attitude towards some important E.N.T. Problems in Present Day Germany

The clinics visited were essentially set aside for the care of civilian cases, though in all a certain proportion of Service patients were admitted for special treatment. No contact was made with any Service Otologist so that first-hand information could not be obtained concerning such problems as air crew selection, barotrauma, and disposal of cases of chronic otitis media in the Wehrmacht. Time was limited and it was not always possible to have the services of a satisfactory interpreter, moreover, the effect of having to receive members of an investigating team comprising uniformed officers of victorious nations sometimes had a damping effect upon those surgeons with whom we discussed medical subjects. News of our arrival was apt to be the signal for halting routine work, the continuance of which is so valuable for stimulating the interchange of ideas. - We often felt in the background a suppressed resentment of our presence, and yet there was an atmosphere of expectation that we could and would use influence to help in the rehabilitation of the medical schools. Despite all these handicaps, it was surprising how much, rather than how little, information we were able to obtain.

It is impossible to give anything but a general impression of German methods and procedure and no attempt will be made to refer to more than a very limited number of them. When reading these notes it should be remembered that during the last two years, so restricted had been the facilities for travel and so curtailed had been all scientific publications, that the "ways" of South Germany may not reflect a true picture of German Oto-rhino-laryngology as a whole. It is proposed to discuss questions of policy, methods and procedure under separate headings.

### Teaching

The same difficulties have had to be faced in Germany as in this country : the Services have claimed young men so soon after qualification that there has been a shortage of aspirants to the specialty. There has been an obvious dearth of text books. Equipment is good, though replacements have been difficult to obtain, for instance the one audiometer in Heidelberg became unserviceable two years ago and repairs have never been effected.

### Deafness

No important new work has been completed, and views about causation, prevention, treatment and instrumental aids remain the same as they were ten years ago. It was hard to escape the impression that deaf people were a nuisance to German Otologists who had been much too busy to expend much time or sympathy upon them. The testing of hearing has been in many clinics somewhat sketchy, pure tone audiometers ~

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not widely used, and nowhere did there appear to be any serious attempt to co-ordinate clinical findings with the prescription of the most suitable type of "deaf aid". This is not surprising, for even the inefficient micro-telephone type of receiver is almost unobtainable, whilst "valve sets" are not made because midget valves are not released for this purpose. Two senior otologists informed me that midget valves were not manufactured, but I find it difficult to believe this statement.

As regards the operative treatment of otosclerosis, no otologist that I spoke to was still performing the fenestration operation. Past disappointments (using the technique of Holmgren and Sourdille) had created a heavy prejudice against the procedure. Lempert's<sup>1</sup> work was generally treated with scepticism; his latest contribution<sup>2</sup> describing the use of a cartilage "stopple" in the foramen novovalis had not reached the country.

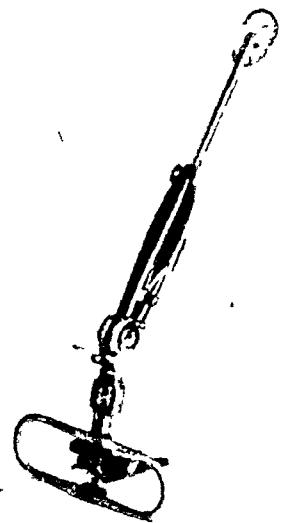
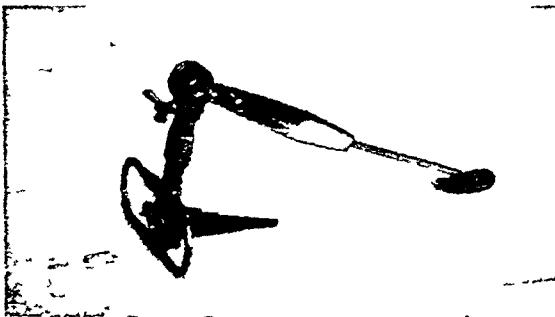
Battle deafness, which includes deafness resulting from blast, aircraft noise and the noise of various instruments of war, is well recognized and its late results viewed with natural apprehension. No otologist interviewed was able to give information about research on ear protection, but it seems clear that, though many forms of protector have been evolved and tried, the superior advantages of intelligently used cotton wool are universally admitted.

## Chemotherapy

No penicillin or analagous drug has been available in Germany. I was informed that promising work had been done on "one of the moulds", but concluded that the product investigated corresponded to Patulin. The various sulphonamides have been used widely, though in an even more haphazard way than is often the case in this country. The pitfalls associated with use of the drugs in question were well recognized, but the practice of testing blood concentrations is seldom adopted. There was a general tendency to administer uneven dosage, and in some cases maintenance doses during the night were considered unnecessary. The most popular sulphonamide has been sulphathiazole, though there have been periods of short supply when use was made of whatever member of the group was available.

In the treatment of acute otitis media, masking of the symptoms of mastoid involvement or the even more serious complications was well recognized; the complacency of general practitioners in administering sulphonamides to every case of otitis media has led to dangerously late diagnosis of serious trouble in far too many cases. I was most interested in the views of Professor Kahler (Freiburg), which so closely resemble my own; he (Kahler) insisted that sulphonamides should not be exhibited in any case of otitis media unless in the early stage the patient

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was gravely ill as a result of co-existing septicæmia, or unless complications were evident. The Professor (in my opinion rightly) pointed out that a high proportion of uncomplicated cases recovered naturally, that the results of cortical mastoidectomy were excellent, and that though in a few cases mastoid involvement was aborted by sulphonamides, this was a high price to pay for exposing many others to the danger of undiagnosed serious trouble. My personal experience in the Army has taught me that sulphonamides are safe and almost infallible in the treatment of a "flare up" in cases of long quiescent otitis media. Such patients, who have had a large perforation (albeit dry) for years may have reinfected the middle ear as the result of swimming; they feel ill, the temperature is raised, and a pulsating discharge is evident. In Germany the favourable reaction of this type of case to chemotherapy had also been noted.

Application of sulphanilamide powder to the bone cavity after cortical mastoidectomy is popular with only a few surgeons.

### Therapeutic Radium Treatment .

Though surface and interstitial application of radium is widely employed, it is clear that in the sphere of teleradiation Germany is far behind the United Kingdom and America. Only in Berlin and Munich had serious work been planned. Dr. Henschke in Munich had used a 1 gramme bomb and experimented with a view to developing a 4 gramme bomb. In these two cities co-operation between physician and physicist was considered essential.

### Treatment of Carcinoma of the Larynx

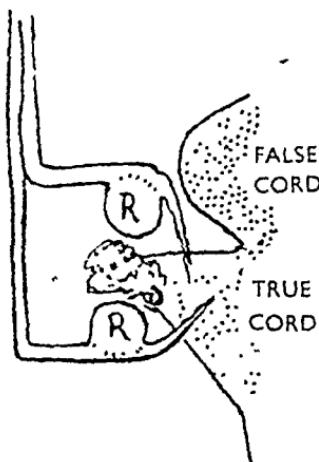
As in other countries, the treatment of this condition varies considerably with the operative skill and humanity of the surgeon. Professor Seiffert, whose operative dexterity is outstanding, performs total laryngectomy upon cases which most surgeons would treat with radiation; he utilizes one incision, which might be described as "left paramedian", and his results are undoubtedly good both from the point of view of rapid healing and freedom from recurrence. In general there is a much greater tendency to fenestration of the thyroid cartilage and application of radium needles. This is probably due to the fact that teleradiation is virtually non-existent.

The greatest diversity of opinion relates to the treatment of early carcinoma confined to one cord when there is no limitation of movement. Both Seiffert and Richter claim excellent results when the growth is very small and free from the anterior commissure, by biting it out with punch forceps large enough to embrace healthy tissue. This is done by direct or indirect laryngoscopy under local analgesia. Höbst favours the clamp (devised by Kraint) which contains a radium needle in each jaw. Under

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local analgesia (by direct or indirect vision) the cord is embraced by the clamp which is held in position by pins transfixing the cord above and below wide of the growth laterally.

The patient who has previously been given morphia and scopolamine, retains this instrument for the prescribed time; on the average five treatments are given. It is claimed that the clamp is well tolerated and that respiratory distress does not commonly occur, but I was unable to check this. Laryngofissure is acknowledged as the best treatment by other surgeons when the cord is freely movable: when doubt arises,



The Kraint Applicator

they have recourse to radium application after cartilage fenestration.

It is interesting to note that few laryngologists have any faith in the Broder classification as a help in selecting the method of treatment, or as a guide to the prospects of curability.

## Carcinoma of Tonsil, Base of Tongue and Epiglottis

Cases which in this country would be treated by radiation are much more commonly dealt with by wide excision with a diathermy knife followed by electro-coagulation of the residual raw area. At Heidelberg I saw cases which had been treated by this method and their subsequent disability was negligible despite an almost frightening loss of tissue.

## Carcinoma of Antrum and Ethmoid Region

In these cases the usual procedure is wide excision, sometimes with the help of diathermy, and more often than not with the subsequent application of radium. Professor Seiffert showed some remarkably successful cases dealt with through a sub-labial incision. In one of these the

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internal maxillary artery had been deliberately tied and the ligature could be demonstrated.

## Petrositis

There is diversity of opinion as regards the most efficient way to deal with these difficult cases. Eagleton's<sup>3</sup> procedure is popular in Heidelberg, but the operation of choice elsewhere is that of Ramadier<sup>4</sup>. Otologists do not differentiate between Ramadier's operation and the more deliberate removal of the bony petrous tip described by Lempert. Professor Albrecht was convinced that in a large number of cases, by "working high" it was possible to do all that was necessary without displacing the internal carotid artery.

## Lateral Sinus Thrombosis

At Heidelberg, Herr Oberartz Hans Denecker, helped by his wife, has developed an ingenious device which will demonstrate clotting (either mural or occlusive) in the lateral sinus without recourse to opening or needling the latter. In cases where sinus and dura of the posterior fossa are widely exposed and yet the line of demarcation is obscure, this instrument shows where dura ends and sinus begins.

The principle is simple and depends upon the speed at which the sinus wall warms up to normal temperature after artificial cooling. Blood flowing naturally through an underlying normal sinus warms up the artificially cooled wall very quickly. Re-warming time is prolonged if the flow of blood is interfered with or if the wall is made thicker by an underlying clot. The area to be tested is touched with a delicate Thermocouple connected with a super-sensitive galvanometer; the galvanometer reading is taken. The area selected is then cooled for 15 seconds by a rubber teat filled with 5 c.c. of water at 20°C. and a second galvanometer reading taken. The cooling bag is removed and the time taken for the galvanometer needle to creep up to the original normal reading is noted. When the sinus is normal the re-warming process is complete in 15 to 30 seconds. If there is an underlying clot this time period is prolonged to over 30 seconds.

A mural clot can be detected by choosing various points on the sinus wall; normal time will be noted for areas above and below the clot, whilst directly over the clot a long re-warming time is evident. As would be expected, these times are modified if the flow of blood through the sinus is slowed down or stopped by jugular vein compression. Should the clot be occlusive the times will be unaltered by jugular compression. Jugular bulb thrombosis can be diagnosed with fair certainty by exposing the bulb, or in the absence of operative exposure can be assumed in occlusive cases by testing the sinus distally with and without jugular compression.

Granulations upon the sinus wall may be gently removed before making tests.

# W. I. Daggett

I am confident that this apparatus works satisfactorily though I only saw it demonstrated to trace out the superficial veins of the arm.

Denecker has described his work to the Heidelberg Medical Society and expects it to be published shortly.

## Ménière's Disease

In severe cases of this disease operative treatment, either by destruction of the labyrinth or section of the vestibular nerve, is not popular. The prejudice appears to be based upon fear of meningitis. As far as I could gather, Wright's<sup>5</sup> method of injecting through the foot-plate of the stapes had not been tried, whilst Cawthorne's<sup>6</sup> technique had not come to the knowledge of otologists. When I discussed Cawthorne's procedure, the attitude was, "What are the advantages of such elaboration ?".

## Barotrauma

This condition is well recognized, but the general opinion is that careful selection of air crew personnel and insistence on operative treatment to correct obvious nasal anatomical abnormalities has rendered the trouble a rare one. The Oto-rhino-laryngologists interviewed stated that they had no knowledge of any work done on radium or deep X-ray treatment to the region of the post-nasal space and Eustachian tube. It was generally admitted that conservative treatment in the acute stage followed, if necessary, by operative treatment for correction of predisposing causes was all that is necessary.

## Endoscopy

Every clinic was supplied with Brünning's Endoscopy Set or Kahler's modification. Jackson's instruments were condemned on the grounds, that the light always becomes fouled. It is tempting to assume that in most cases Jackson's instruments had never been tried. Negus's tubes have not yet been recognized.

## Pathology

At the Freiburg Clinic, Dr. Otto Riecker has experimented upon guinea-pigs in the decompression chamber and has demonstrated that lack of oxygen has constantly given rise to vacuolation of Deiter's cells in the Cochlea. This work, as far as can be ascertained, has not been repeated upon human beings from the concentration camps.

## Apparatus

I did not see anything worthy of note in the way of new instruments. Denecker at Heidelberg demonstrated to me the use of Professor Seiffert's

## Oto-Rhino-Laryngology in Germany To-day

self-retaining laryngoscope, and I have never seen a better view of a child's larynx. Both hands of the operator (who wore a forehead mirror for illumination) were free to perform any manipulations. For those who have not had the opportunity of seeing Seiffert's text-book (published before the war), two photographs of this instrument are included.

### The Scope of E.N.T. Surgery

In general, the oto-rhino-laryngologist in Germany does not limit his surgical activities so much as does his counterpart in this country. Surgery of the neck, particularly gland clearance, is regularly undertaken. Seiffert does almost as much plastic surgery as routine E.N.T. operative work.

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## FENESTRATION OF THE LABYRINTH

By I. SIMSON HALL (Edinburgh)

IT has long been the ambition of otologists to restore the hearing of those regarded as incurably deaf, but the first proof of the possibility of so doing was given by Kassel in 1876, who, by removing the stapes, caused a transient improvement.

This was verified by Passow in 1897, who trephined the promontory, but again the improvement lasted only a few days.

These early attempts were abandoned owing to severe criticism of the dangerous methods employed (Politzer, Subentan, Rosey, Denker).

The matter was in abeyance till 1912, when Bárány foreshadowed the present methods by proposing the creation of a fistula in the posterior-vertical canal. Again results were transient. Jenkins in 1913 was the first to use the horizontal canal and to cover the fistula with a graft or flap. Lack of success in obtaining a lasting result caused him to abandon the operation.

Fraser of Edinburgh, about the same time, experimented with this method, but suffered the same disappointment.

Kisch in 1913 reported two cases to the Royal Society of Medicine in which an opening had been made in the promontory.

Holmgren of Stockholm was the first to explore fully the various methods of opening the canals. Commencing his work about 1917, he studied every aspect of the problem and his pioneer work in development of technique deserves the credit for establishing this procedure as a recognized surgical operation.

After Holmgren, Sourdille of Nantes, encouraged by the success in Stockholm, further elaborated the operation and reported a large series of cases with improved results. He insisted that the operation should be carried out in stages which were, in effect, designed for the preparation of the flap which was to cover the new opening, and also to safeguard the labyrinth from infection.

Since the publication of Sourdille's work, literature has accumulated rapidly as many surgeons commenced experiments along similar lines.

Campbell, Lempert, Shambaugh, Rollin, Kopetzky and others published results and modifications of the operation.

All of these workers, however, follow the same method in essential particulars, that of making a new opening in the labyrinthine capsule and covering it with a pedicle graft to obtain a mobile membranous

## Fenestration of the Labyrinth

opening to compensate for the immobilized stapes. How this is achieved varies in detail of approach, of the degree of ossicular removal, the position and size of the opening, and the technical method.

The most important variations appear to be the number of stages of the operation, the removal of the incus and the exact position of the opening in relation to the ampulla of the horizontal canal. The development of technique has demanded increasing accuracy of work so that it is now accepted that adequate magnification is essential and most workers have found that the dental drill is the most suitable instrument with which to open the labyrinth.

It will be seen therefore that the operation as at present performed is the culmination of thirty years' work on the part of several workers. As might be expected, methods have changed to a very great extent, and the operation while following the principles of the early surgeons, is carried out on lines allowing for much more accurate and scientific study.

About nine years ago, when the series under review was commenced, equipment was primitive. A scraper, usually a mastoid gouge or some such instrument, was used to make the opening in the labyrinth capsule, magnification was negligible, and the operation, under these handicaps, took a very long time.

To-day, magnification is obtained by the use of a dissecting microscope giving a wide range of powers, an elaborate set of dental drills, and other instruments specially made to enable the operator to form his opening where and how he wishes with perfect accuracy. The operating field is kept clear of blood and debris by an irrigating apparatus which can be used either intermittently or continuously as desired.

### Apparatus

The microscope used by the writer is a "Reichert" dissecting microscope, which gives magnifications of from about six times to fourteen times, the difference being obtained chiefly by eye-piecing. The working distance is on the average 15 cm. but depends to some extent on the magnification used. (Fig. 1). The distance of the operator's eye from the patient is just that at which he is accustomed to work; this is a very important point for the avoidance of fatigue. The working distance is also of the utmost importance, for it must be sufficiently great to allow easy access to the work. Some microscopes are very bulky, and in that case greater working distance is necessary. The instrument in use at present is exceptional in that respect and the distance quoted is ample. A "Zeiss" microscope has been used also but comfort and working distance are less than in the case of the "Reichert", so that it is now used chiefly for photography and certain special occasions when its superior optical system is advisable.

The microscope, of whatever type, should have a lighting apparatus

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integral with the instrument, and ample margin must be allowed, for really good illumination is indispensable. The writer uses a 100 watt cine projector type of bulb, but the lamp design is probably of greater importance than "wattage".

The drill is a standard flexible drive as used on ordinary dental engines, with a straight dental handpiece. This is driven by a motor with a foot control, which can vary the speed as required. High and low speed motors have been tried, and the conclusion formed is that it is better to use a more powerful motor which will work steadily at quite low speeds even though it may be a little more bulky.

The drills are of many types and every worker has his preference, but a wide range is required from the larger fast cutting drill for smoothing off rough portions of bone, to the finest obtainable for thinning the roof of the vestibule.

Various scrapers and excavators similar to dental instruments are ground under the microscope to make it possible to reach and shape any part of the labyrinth opening. These are used for smoothing the edges, removing the endosteum, and extracting chips of bone which may have slipped into the canal or vestibule.

Irrigation in one form or another has been used since the early part of this series, and this is felt to be the most important part of the apparatus after magnification.

However arranged, the irrigation should be capable of adjustment within fine limits for volume, and should be able to be used continuously or intermittently as required. In the apparatus described, a valve is provided by which the flow can be controlled by the assistant at a word from the operator.

The question of sterility of the apparatus has been given much thought, and some of the elaborate precautions used at first have been abandoned, such as a sterilized cover for the microscope. Now, a sterilized lever and guard is screwed on to the focusing device of the objective and by this the operator controls the microscope. The supports and swinging arms are all covered with sterilized material, and the flexible drive is run through a sterilized cover which is attached to the thumb ring of the sterile hand piece. The hand piece itself is boiled in oil and lubricated with sterile liquid paraffin. It appears to tolerate this treatment excellently.

A point, small in itself, but which has added considerably to the comfort of the operation has been the provision of a small adjustable mirror fixed to the microscope through which the assistant can follow the operation. (Fig. 2.)

## Anæsthesia

Different methods of anæsthesia have been used but the ideal has yet to be discovered. Each method has its own advantages. Local

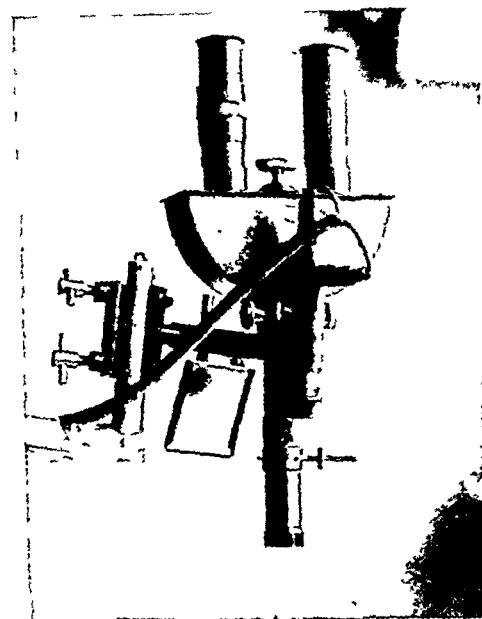


FIG. 1.

Micro-scope showing sterilizable focusing lever, assistant's mirror, attached spot light.

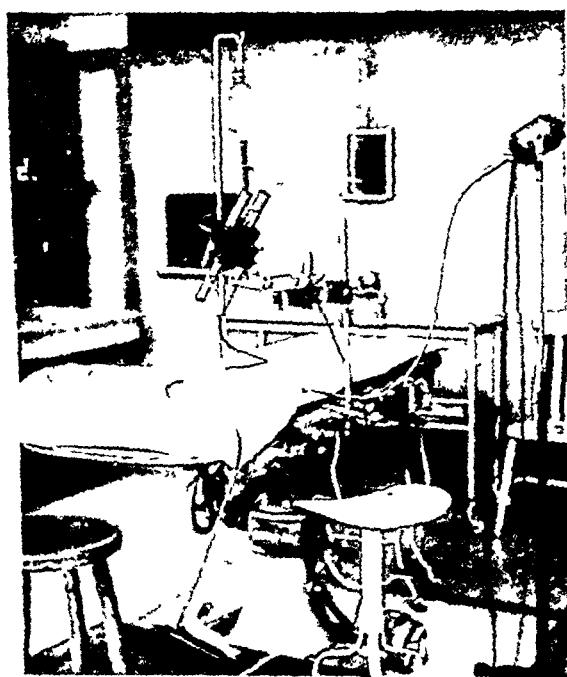


FIG. 2.

Apparatus erected showing micro-scope on swiveling adjustable arm, motor and flexible drive foot switch irrigation apparatus and suction line

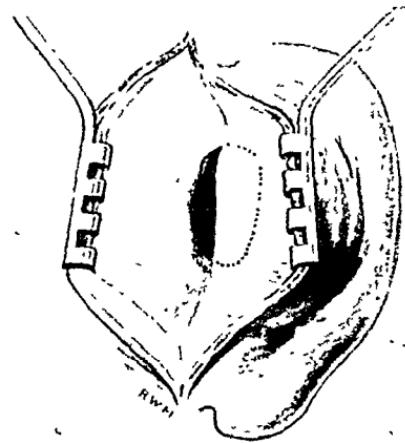


FIG. 3.

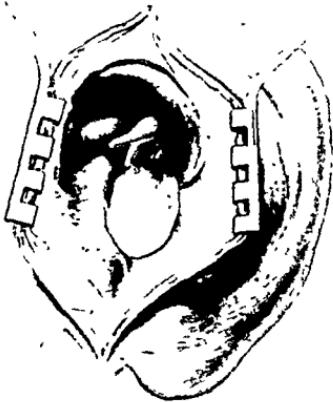


FIG. 5.

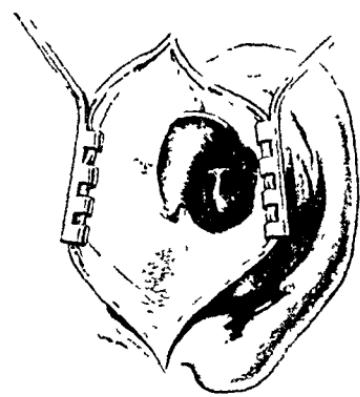


FIG. 4.

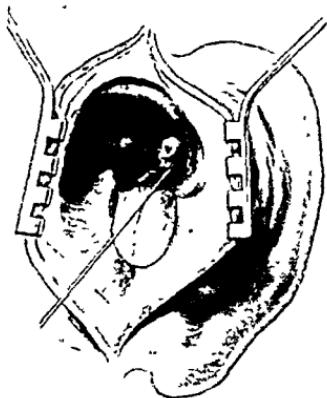


FIG. 6.

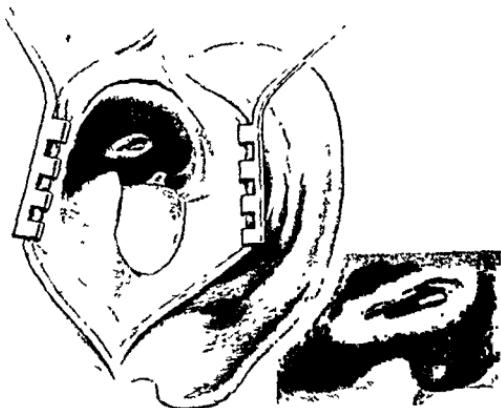


FIG. 7.

The bone in this specimen was exceptionally thick. The artist has drawn accurately what was seen but usually the opening is wide and of saucer shape, and much shallower

## Fenestration of the Labyrinth

anæsthesia gives an almost bloodless field, and permits the testing of hearing on the table, but unless premedication is pushed to a point where the second advantage is lost, the patient frequently becomes distressed when the labyrinth is opened.

In conjunction with local anæsthesia, a method which has been found effective is to use local anæsthesia up to the point where the labyrinth is opened, and after testing the hearing, should there be any distress on the patient's part, pentothal sodium is administered for as long as is necessary.

Avertin and other basal narcotics have been tried but did not appear to have any outstanding advantages.

In the latter part of this series of operations a heavy premedication followed by light ether anæsthesia has been the method used and this has proved, on average, the most satisfactory, for the delay caused by any increased bleeding has been more than compensated by the increased speed which can be achieved under general anæsthesia, and by the fact that the patient is completely immobile. It is difficult to eliminate movement altogether, with local anæsthesia, and when using the microscope much time can be wasted in readjustments when the patient is restless. Difficulties with haemorrhage are reduced to a minimum if saline with adrenalin is injected at the beginning, and irrigation is carefully controlled.

### The Operation

The duration is, on the average, about two hours. The operation falls naturally into two parts, the preparation of the middle-ear cavity, and the trephining of the labyrinth. The break in the middle of the operation, which is occupied in the adjustment of the microscope and other apparatus, takes about fifteen minutes.

The incision used in this series has been the post-aural. It does not seem to be of any moment to the operation what incision is favoured so long as it is familiar to the operator.

The writer has used the endaural approach in mastoid surgery sufficiently often to find it a matter of indifference which method is used, and the opinion formed was that, as far as this operation is concerned, the problems of magnification, lighting, and irrigation are more easily solved by the standard post-aural incision.

The point of greatest importance is that as this operation is of much greater technical difficulty than a radical mastoid operation, the surgeon should hold to those methods in which he is trained, rather than adopt the unfamiliar, in the belief that it is an essential part of the operation. The first part of the procedure is very similar to the modified radical mastoid operation so that whatever is the accustomed procedure in that, should be used in the labyrinth fenestration.

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Before incision is made, the area just behind the auricle and the area of the roof of the external meatus, are infiltrated with adrenalin-saline solution, to assist haemostasis.

After incision, elevation of the soft parts is carried out with care, as on no account must the posterior meatal wall be injured. With a small elevator such as is used for a nasal septum, the periosteum of the posterior wall is carefully freed for some distance towards the drum membrane. It is not advisable at this stage to attempt to carry the elevation down to the tympanic ring. The formation of what is called the "meatal plastic" is then undertaken. An incision is made in the postero-superior wall, of horse-shoe shape, commencing at the point where the anterior horizontal ligament is attached to the tympanic ring, and curving round to finish at the junction of the posterior part of the ligament with the tympanic ring (see Fig. 3).

The flap so outlined should not encroach on the cartilaginous part of the meatus. This tissue must be elevated from the bone with the greatest care, particularly in the roof of the meatus, where it is densely adherent at times to a bony ridge which may vary both in size and extent. (Fig. 4.)

The success of the operation as a one-stage procedure depends upon an intact flap, as, if it is torn, the operation may have to be abandoned or completed as a two-stage operation.

Removal of bone is then carried out as in the radical mastoid operation, till the contents of the middle ear are exposed. The outer part of the attic roof and the facial ridge are removed as in the standard operations, but it is unnecessary to carry out any bony removal posteriorly, except such as the operator feels is necessary for access. (Fig. 5.)

The capsule enclosing the heads of the ossicles, is opened with a fine knife, and the heads of the malleus and the incus are separated. This permits the easy removal of the incus without damage to other structures.

The head of the malleus is then divided with a fine pair of scissors at the neck, and removed. (Fig. 6.)

The first stage of the operation is completed by the enlargement of the external meatus by the operator's usual method, and it should be kept in mind that adequate access for after-treatment is essential for success.

The arranging of the apparatus for the second stage makes a break in the operation which is used to change gloves and gown, and adjust the microscope. Fresh towels are spread and the trephining of the labyrinth is commenced.

The position of the opening is selected at a place where it is judged that it will be over the ampulla of the horizontal canal.

If a line is taken upwards from the head of the stapes to cut the Fallopian canal at right angles, and a point selected just anterior to

## Fenestration of the Labyrinth

this, it will be found in the majority of cases to open the vestibule in the desired position.

A fast cutting burr is used to thin the roof over a wide area and a saucer-shaped depression is made and deepened till the cavity of the vestibule shows through with a bluish tint. The depth of the bone varies within wide limits, and a considerable thickness of bone may have to be removed before the cavity is reached. Bone dust, and debris is removed continuously by the irrigating apparatus, and bleeding rarely gives trouble at this stage provided irrigation is properly adjusted, not only for volume, but for direction. Should a vessel in the bone prove a hindrance, as will occasionally happen, it is most easily dealt with by running over it with a fine polishing stone.

As the bone over the vestibule becomes thinner, change is made to finer and still finer drills, till nothing is left of the covering except endosteum and the thinnest of bone.

Every endeavour should be made to preserve this plate intact till the operator is ready to open it after having thinned out the bone equally all over. In such circumstances it is possible to remove the most of the endosteum and the remaining bone in one piece, a circumstance which not only shortens the operation, but renders it possible to leave the final opening cleaner and freer of particles of bone and shreds of endosteum.

As soon as the endosteum is removed the membranous canal and ampulla should be clearly exposed. With the small elevators and scrapers, the opening can be enlarged in any direction necessary, and with the membranous canal in view, this can be done with safety. The edges of the opening are also cleaned of endosteum and small chips are picked out with special needles. It is during this part of the operation that adequate magnification is essential, and it is useful to be able to increase the magnification for any particularly difficult piece of work. (Fig. 7.)

The small meatal flap is then spread over the opening, and secured in position with paraffin packs. The posterior wound is closed with interrupted stitches.

### Post-operative Treatment

The wound is left undisturbed for five or seven days, after which the first dressing is carried out. An anaesthetic is always employed for this, and pentothal sodium is suitable. As there is usually a little bleeding at the first dressing, a light pack is placed in the cavity for the first day, after which it is discontinued. In the majority of cases, skin grafting is carried out at this point, either by Thiersch, or pinch method, and some form of pack or filling will be required for a few days if this is done; if no grafting is resorted to, then treatment consists of mopping, and powdering as in any mastoid cavity.

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If granulations make their appearance they are taken down as usual. Boric and iodine powder is frequently employed and sulphanilamide powder has been used but it does not seem to have any advantage over the other.

Healing takes on the average six to eight weeks, and it cannot be too strongly emphasized that the patient must be treated to the point of complete healing and the last part of the treatment must not be delegated to the patient's own doctor or nurse, no matter how persuasive the patient may be. Thereafter, the patient must be seen at regular intervals, which may increase in length as time passes, but they must be of sufficiently short duration to ensure that the cavity does not become obstructed with wax or debris.

The duration of stay in hospital depends upon the distance of the patient's residence from the hospital. If the patient lives sufficiently close to the hospital to attend for daily treatment the stay in hospital need not exceed a fortnight, or at most, three weeks.

## Post-operative Effects

Immediately after the operation the patient exhibits all the signs of labyrinthine irritation. Giddiness, sickness occasionally, and nystagmus of labyrinthine type to the opposite side, are usual. These symptoms persist, to a troublesome degree for about four days, after which they are noticeable to the patient only on movement.

Reactions may vary greatly in individuals, but they are most marked in older people, and in them, they are apt to persist longer. Lack of balance, however, seldom persists sufficiently long to cause real trouble.

## Complications

There have been no cases of labyrinthitis, or facial paralysis. The most troublesome complication has been infection of the cavity, and it has been the experience of the writer that nothing militates against success so greatly as this type of infection. Otitis media has been encountered in three cases, and while causing considerable anxiety, it does not of necessity, imply failure.

There have been two deaths. One due to morphia idiosyncrasy and one to acute cardiac failure in an elderly woman, both occurring after the operation had been successfully concluded.

## Results of Operation

In this series, a total of one hundred and two operations have been done in the nine years up to July 1945. During this period the technique has varied greatly and so many operations have been undertaken for the purpose of experiment on what were suspected to be unsuitable subjects, that any statement of total results over the whole series has practically

## Fenestration of the Labyrinth

no meaning. A much more detailed analysis is necessary if anything is to be learnt from these experiments.

It is a matter of experience that if improvement in hearing persists for more than four months, it is likely to remain for some time, therefore all cases operated upon within the last five months must be excluded, however promising the immediate post-operative condition may be.

It is obvious also that cases operated upon with the primitive equipment used in the earliest cases should not be assessed in the same series as the later cases which have had the benefit of up-to-date methods.

When these cases have been extracted there are left seventy-one cases for analysis. If a total figure is desired, the percentage of success over all cases operated upon is 54·9 per cent., but this should be taken bearing in mind the warning given above.

Improvement in hearing varies in individual cases from five decibels to thirty decibels over the speech range of frequencies, and in a favourable case, twenty-five to thirty decibels may be expected at the optimum period. This is usually immediately after the ear has completely healed, and it may last for weeks or months. It is found that after an interval of eighteen months to two years that the acuity diminishes in most cases till a permanent level of fifteen to twenty decibels gain is reached.

In deciding for the purposes of this analysis what is to be classed as "improvement", no case is accepted as improved where the patient is not conscious of the increased acuity of hearing.

As very few, if any, can appreciate a gain of five decibels, it will be seen that the minimum improvement must be in the region of ten decibels.

Another point which deserves consideration is that the total gain at any time subsequent to the operation, is the difference between the two ears.

Since experience shows that even where a large initial gain is not obtained the deterioration of hearing is arrested, it follows that the benefit to the patient includes the amount lost by the ear not operated upon, as on the average, deafness is progressive in both.

	No	Immediate Failure	Late Failure	Lost	Still Improved	%
1939-40	13	4	2	1	6	50
1940-41	7	1	2	2	2	40
1941-42	nil	nil	nil	nil	nil	nil
1942-43	27	8	2	3	14	58·3
1943-44	17	4	—	—	13	76·4
1944-45	7	1	—	2	4	90
Total	71	18	6	8	30	54·9

FIG. 8

Table showing present condition of the groups operated on during past six years

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One of the most discussed points in regard to the operation is the question of the duration of the improvement, and a table (Fig. 8) has been prepared to give some idea of the length of time over which the improvement has been retained in the various groups of cases operated upon during successive years.

This affords a much fairer picture of the prospects of success, for as might have been expected the most recently performed operations show a much higher percentage of success. The question must be asked immediately, whether this improvement is not due entirely to the short period since the operation.

It is unlikely that this is so altogether, for a reference to the table shows that the immediate failures are no greater than in the previous groups. It will be seen also that the number showing late deterioration is fairly constant throughout, so that it is probable that the latest group will show a higher percentage of final improvement.

This improvement may be explained in several different ways. The technique may have altered radically, the operator may have gained in skill, or the selection of the patient may have been carried out in a more critical manner.

There is no doubt that technical efficiency has increased, but this would account for only a small part of the gain, for some of the earlier cases are amongst the most successful. (Fig. 9.)

The importance of differences in method are shown by the fact that the removal of the incus (54 per cent. success) gives a clear gain over its retention (31 per cent. success) in a comparable series of cases. This question of removal of the incus received at one time a great deal of prominence, some writers insisting that it was essential to a good result. Since there was practically no difference immediately after operation, we must look for the explanations of the final gain elsewhere, and to some influence on the remote effect. The most reasonable explanation seems to be that the removal of the incus permits of the opening being made more anteriorly over the ampulla, and also permits of the opening being larger.

### Revision of the Fenestra

Only three revisions have been undertaken, and the results have confirmed the opinions of others who have carried out similar operations. The hearing is again restored, and improvement is maintained at least for a longer period than in the first instance. The difficulty of this operation should not be under-estimated, for it is considerably more delicate a procedure than the primary operation.

On one occasion the membranous tube was firmly adherent to the fibrous tissue filling the window. The subsequent dissection necessary to release the membranous canal without damage required both a high degree of magnification and great patience.

## Fenéstration of the Labyrinth

It is noteworthy that it was very much simpler to revise one of the earlier cases in the series than the latter, because in the former the more posterior location of the opening on the horizontal canal made it possible

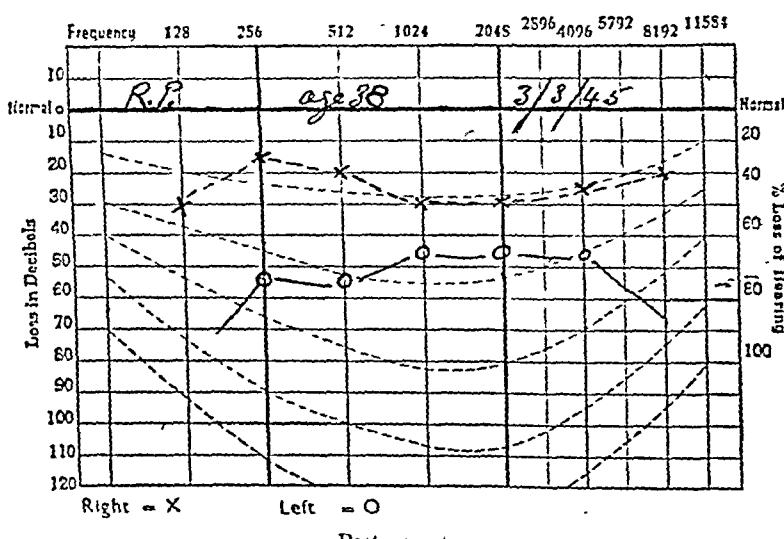
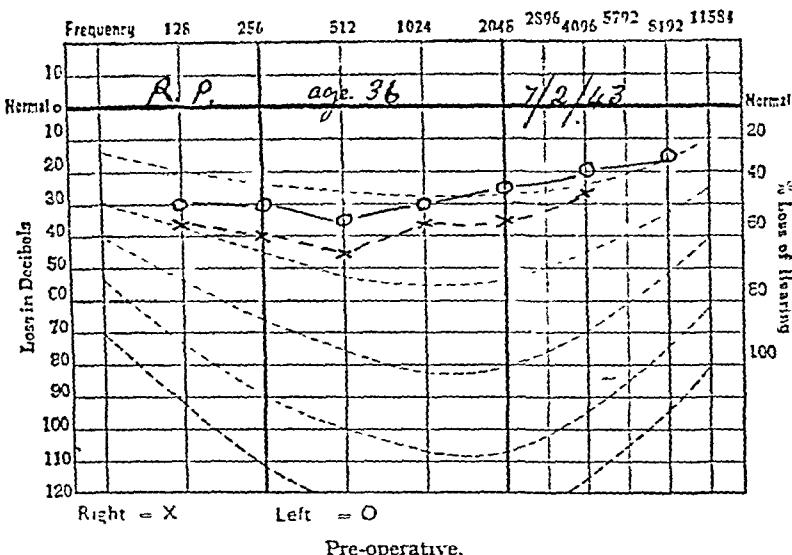


FIG. 9.  
Typical charts in a favourable case.

to make a new opening in front of the adhesions, while in the case of an opening over the ampulla, it is necessary to pass directly through the old opening. In view of the risks to the labyrinth and the fact which has

# I. Simson Hall

emerged that the deterioration of hearing in the affected ear is arrested in many cases which are classed as unsuccessful, it is doubtful if revision will become popular, and its advisability has still to be decided.

## Effects other than upon Hearing

Confusion of sounds is the rule after operation. The chief complaint is noise, which at times seems to prevent the patient hearing anything, and the patient has to learn to pick out voices from the volume of amplified sound. This may involve a retraining which makes intelligent co-operation on the part of the patient essential. Some patients of the less intelligent type have failed to make full use of an obvious increase in hearing.

Failure to orientate sounds is an interesting phenomenon which has been noted on several occasions. One patient stated that she continually

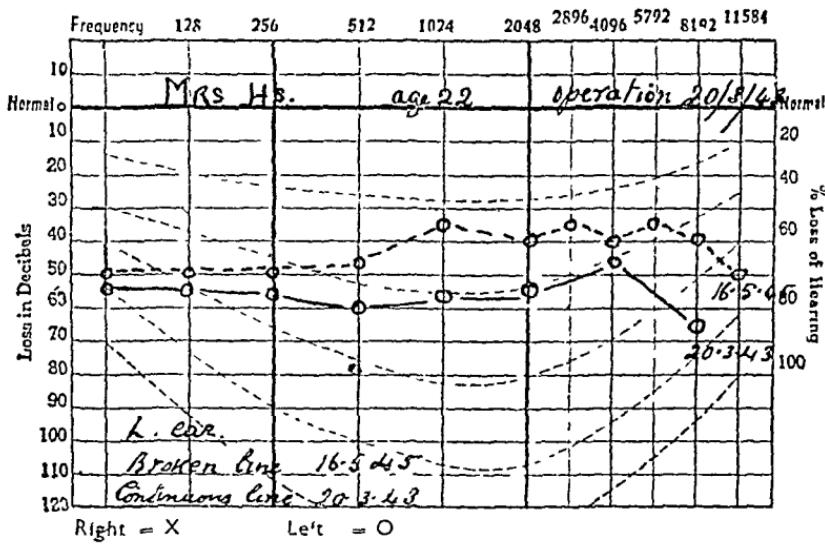


FIG. 10  
Pregnancy 1943

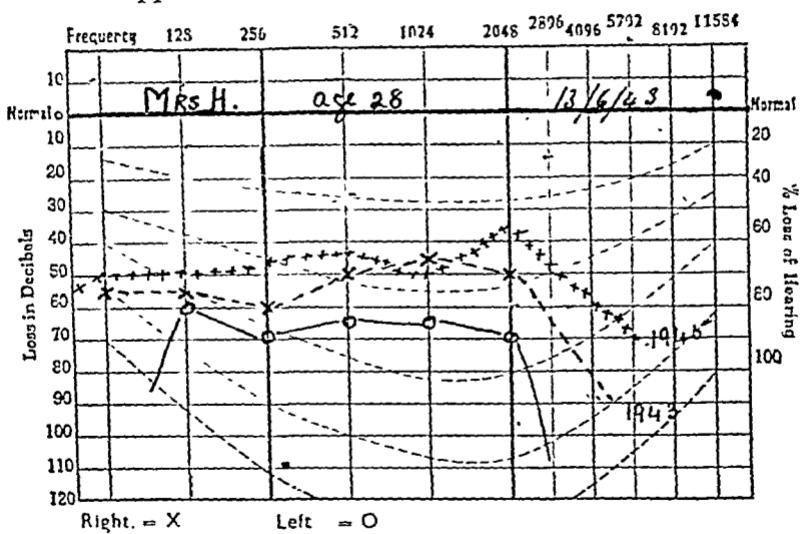
looked to her right when spoken to on the left, and on more than one occasion patients have been seriously alarmed because the sound of an approaching street car seemed to be behind them on the pavement.

Vertigo has been referred to as a direct sequel of the operation, and as such it can be expected to subside rapidly. Occasionally it may persist to a greater or lesser extent, and some patients, particularly older people, have a degree of imbalance for some weeks. Any circumstance which interferes with the newly-made fistula will produce violent symptoms, and the patients must be warned against interference with the ear.

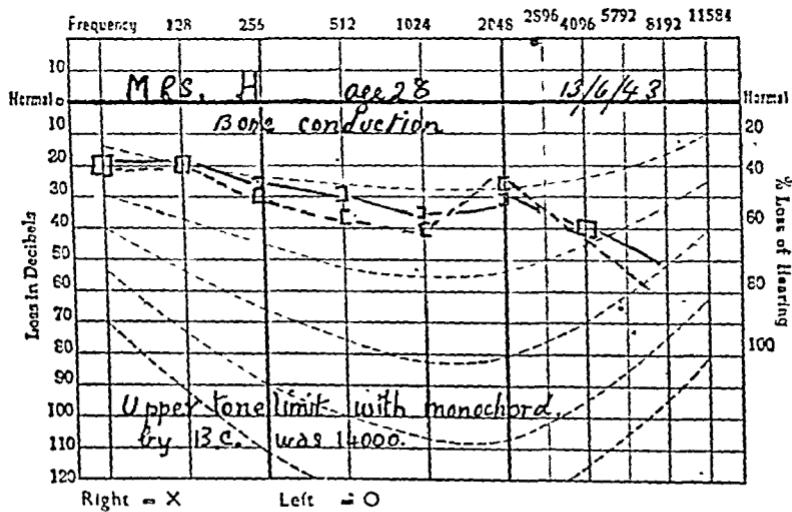
Pregnancy has always been recognized as likely to cause increase in deafness. Four patients have become pregnant after operation. In

# Fenestration of the Labyrinth

one case there was marked deterioration of hearing but in the others there was no apparent change. On such a small number no advice to



Improvement shows that good results can be obtained in such cases.



Example of unfavourable case showing signs of nerve deafness.

FIG. XI.

patients could be formulated but it is noted as a matter of interest. (Fig. 10.)

The effect on the employment of the man or woman after operation has been the cause of some study, and there does not appear to have been any influence in any case except one in which a young man, a riveter

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by trade, found the reverberation distressing when riveting inside a boiler. The majority of the patients operated upon have been sedentary workers to whom these considerations did not apply.

## Selection of Patients

For the production of good results careful selection of patients is essential, and sufficient work has now been done to permit selection of

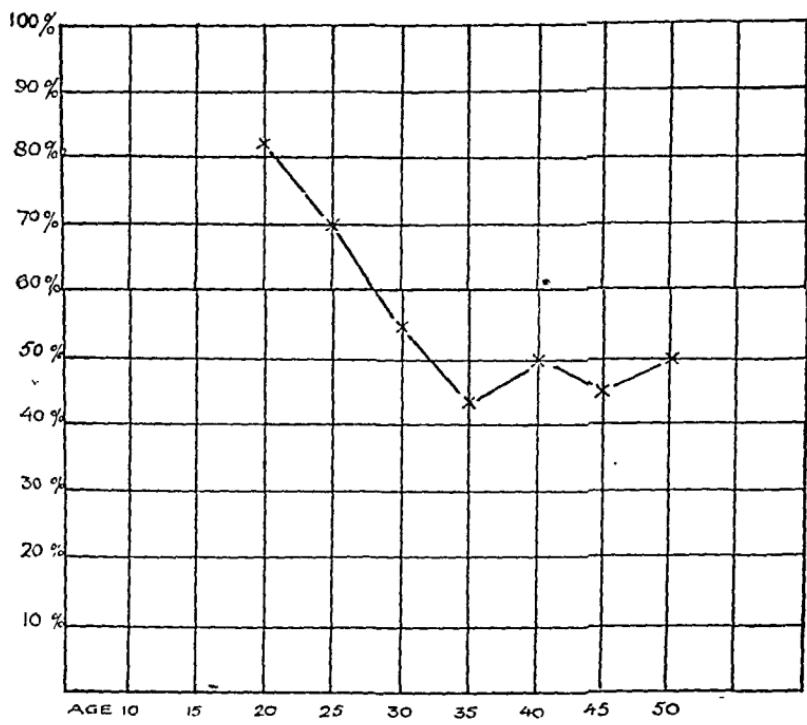


FIG. 12.

Showing influence of age on results. Improvement at higher ages is possibly due to great care in selection of cases.

the favourable cases and so raise the percentage of success. If a worker adheres rigidly to the rules of selection, he will be able to produce from 75-80 per cent. of immediate improved hearing and he will be able to quote a very successful series of cases. It is found occasionally, however, that a brilliant result is obtained in an apparently unfavourable instance, and for this reason continued acceptance of these cases is advisable as experimental material. Quite a large number of those in this series have been operated upon who would not otherwise have been considered suitable. (Fig. 11.)

There are, however, certain types of patient who are generally recognized as being unsuitable. Amongst such are those who show

## Fenestration of the Labyrinth

evidence of previous middle-ear disease, and those who show signs of marked inner-ear deafness.

The age of the patient has an influence upon the prognosis, as can be seen from the accompanying graph (Fig. 12).

Sinusitis and nasopharyngeal disease are also contra-indications. The characteristics disposing to a favourable result are fairly definite. The patients are usually under thirty years; deafness is not extreme, and there is neither sign nor history of middle-ear disease. As mentioned above, there is no sign of nerve deafness. The patient is also intelligent. Some cases can be selected for operation at the first interview, when it is found that there is already serious disability, and it is certain that there has been steady deterioration of hearing. On the other hand, when a patient is encountered with the ideal condition of only moderate disability, then repeated examinations at intervals are advisable to check and estimate the rate of progress of the deafness.

Tuning fork tests are done as routine, but reliance is placed chiefly upon the audiometer record, though it is recognized that this is not always reliable of itself in diagnosing cases of nerve deafness. It has been found that appreciation of the upper tones when using the monochord by bone conduction, is a useful indication of the probability or otherwise of success.

X-rays have not been found to give any information of real value, and they are not now part of the routine investigation. The vast majority of the bones operated upon have been found to be cellular.

### Causes of Failure

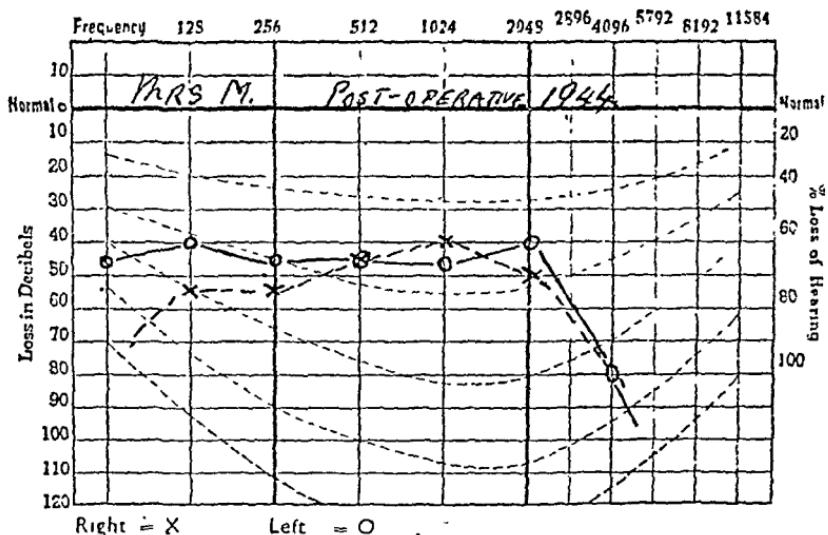
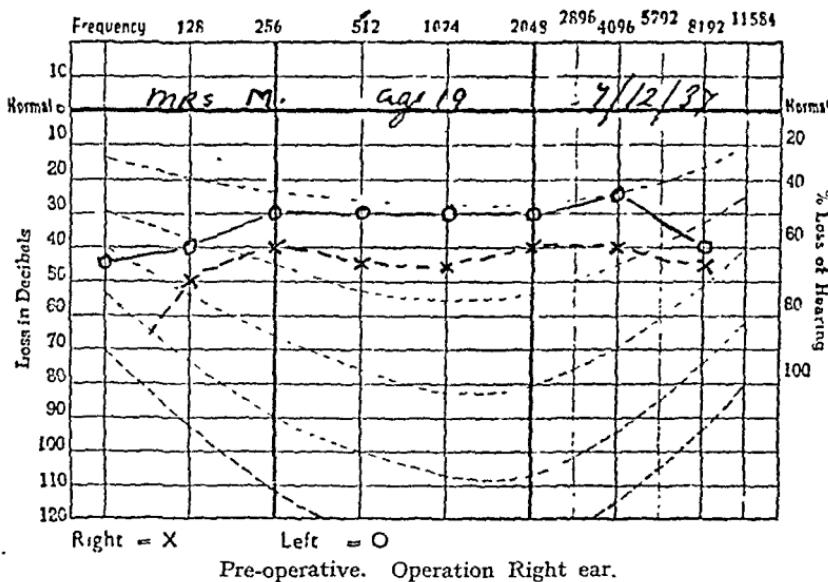
These may be summarized briefly. Advancing age and the presence of nerve deafness, infection of the cavity, otitis media, and intercurrent infection. Technical failure, no doubt, is of importance, but there is only one case in this series in which a breakdown in the electrical system directly contributed to failure. Signs of previous disease have been encountered at operation when it was recognized that a good result was not to be anticipated. An example of this was a case of healed labyrinthitis.

Closure of the fenestra although left to the last, is the most important cause of failure, and the one over which there is least control. There is no doubt that, generally speaking, the final success of the operation depends upon the persistence of the fistula. Cases have been reported in which a persistent fistula has been found in patients showing steady deterioration of hearing. That has been the experience in certain cases of this series, but there is a very great difference between the active violent reaction of the wide open fistula and the increasingly sluggish reaction of the fistula which is beginning to close.

Also, cases have been reported in which there has been improvement

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although the fistula has apparently closed. These cases, however, seem to be amongst the exceptions, and little though we understand them, they do not affect the main conclusion.



Operation Right ear. Shows maintenance of hearing in operated ear and loss in the other

FIG. 13.

It is the closure by bone or fibrous tissue which is the core of the problem and upon its solution depends the ultimate success of the operation. The answer is still awaited, though cartilage implants may be a help.

As has already been pointed out, however, though cases which do not

## Fenestration of the Labyrinth

show improvement are listed as failures, the result is not so disappointing as might be expected because it has been found that although the level of hearing has not been raised in the ear operated upon, the depreciation in hearing has been arrested. This can be seen clearly by comparison with the other ear which has not been operated upon. (Fig. 13.)

In conclusion, it may be asked whether in view of the imperfect character of our knowledge, it is worthwhile pursuing this tedious and time-consuming procedure. The patients themselves may be left to supply the answer, and the fact that a large number of those on the waiting list are there on the recommendation of their friends, shows that if they are willing to undergo the discomforts and uncertainties of this lengthy hospital treatment, the benefits which they have observed in others must be worth obtaining.

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## CLINICAL RECORD

### CASE OF LEFT TEMPORAL LOBE ABSCESS, EXTRADURAL ABSCESS AND LATERAL SINUS THROMBOSIS, FOLLOWING EXACERBATION OF CHRONIC SUPPURATIVE OTITIS MEDIA. DRAINAGE, RECOVERY

By L. BOSS (London)

THE management of cases of abscess of the brain secondary to ear disease still presents many problems and the literature reveals a wide variety of opinions as to how and when such cases should be drained and in what manner the drainage should be maintained ; only on one aspect of the treatment opinion seems to be unanimous : that the abscess should be drained in such a way as to avoid spread of the infection to healthy tissue inside the skull. Cases of recovery after an operation on otogenic brain abscesses were rare and unexpected not so long ago. The percentage of recovery has doubtlessly increased of late, but unfortunately we are still far from being able to regard recovery after such a complication as the rule. It is therefore advisable, I think, to publish short clinical accounts of all patients who have recovered in order to provide more evidence for the solution of those questions which are still much under discussion and which are vital for the surgical success, i.e.

1. What early signs are most constant and helpful to establish the diagnosis and to locate the abscess.
2. What type of drainage offers the greatest promise ?
3. When should the abscess be drained ?
4. Can chemotherapy prevent the occurrence of brain abscess, or alter the course of the abscess, once established ?

The following case came under my observation :

A girl of 16 was admitted to Joyce Green Hospital on *October 7th, 1943*, with a history of left aural discharge of some years duration, and recent left earache.

*On admission.*—Left ear : offensive, pulsating discharge from attic region, polypoidal granulations present in roof of middle ear. Some mastoid tenderness. Whispered voice reduced to 1 ft. Temp. 100-102. C.N.S., Fundi—nothing abnormal found. Vomiting in the evening.

12.10.43.—Left cortical mastoid operation ; large extradural abscess of middle fossa ; dura bulging and discoloured, subdural puncture did not reveal any pus ; lateral sinus : complete thrombosis, sinus incised, thrombus removed. Culture of pus : Gram-positive cocci, overgrown with *B. proteus*.

14.10.43.—General condition improved, temp. subsiding under Sulphadiazine.

17.10.43.—Patient complained of headache. C.N.S. : weakness of contralateral abdominal reflex. Lumbar puncture : pressure increased (155), 53 lymphocytes, 1 polymorph.

# Clinical Record

18.10.43.—Increasing frontal headache, patient slightly drowsy, nominal aphasia appears.

19.10.43.—L. mastoid reopened, middle fossa exposed over a large area; tegmen tympani and parts of the squama removed. Puncture of l. temporal lobe reveals abscess 1 to 1½ cm. deep and 3 oz. of foul smelling pus was aspirated. Incision of the dura and insertion of two rubber drains into the abscess cavity. Middle ear cleaned of cholesteatoma, radical mastoid completed.

20.10.43.—Aphasia gradually disappearing. Abdominal reflexes present again. L.P.: normal pressure. 29 lymphocytes/cm. Drainage satisfactory, Chemotherapy discontinued. (Total: grm. 98 Sulphonamide.) Left fundus: ill-defined margin.

To 9.11.43.—After a transient insufficiency of drainage to which the patient reacted with a slight frontal headache and weakness of the contralateral abdominal reflex, she continued to make good progress so that the tubes could be removed.

8.12.43.—No further localizing cerebral symptoms. Right abdominal reflex present, general conditions excellent.

23.1.44.—After closure of postauricular wound and meatal plastic, patient is discharged from the hospital.

Present condition: Started work as shop assistant on 1.7.44, and has been well ever since.

## Comment

1. *Diagnosis*.—There can be little doubt that the abscess was already present at the time of the first operation: exploration of the temporal lobe, however, seemed unnecessary, as both the lateral sinus thrombosis, and the extradural abscess, apparently explained the clinical features. The disappearance of the contralateral abdominal reflex has proved again its reliability in the early diagnosis of temporal lobe abscess. The importance of aural pain in chronic middle-ear suppuration, and of frontal headache when persistent after mastoid operation, deserve emphasizing.

2. *Drainage*.—The period of drainage in this case was rather long, but I believe that prolonged tube drainage is never harmful and obviates pocketing. Emphasis has to be laid not so much on the type of drain employed, but on the gentleness of its action, the need of avoiding any trauma to the wall of the abscess, and, generally the abstention from any activity, unless necessitated by inadequacy of drainage.

3. *Timing the drainage*.—It is frequently stated that the abscess should be allowed to become localized and encapsulated before being drained. This is probably the right method for many cases. However, in the acute flare-up, as in this case, the mastoid should be drained without delay as soon as the diagnosis has been established, in order to eradicate the "factory of organisms" (Layton) and to prevent further spread.

4. *Chemotherapy* may have controlled the infection of the lateral sinus, but did not stop the development of the brain abscess.

I express my thanks to Dr. Mitman for permission to publish these notes and for his advice and help in the administration of chemotherapy.

## SOCIETIES' PROCEEDINGS

### ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

February 2nd, 1945

President—C. GILL-CAREY, F.R.C.S.Ed.

#### Discussion on Treatment of Carcinoma of the Larynx

E. D. D. DAVIS: *A review of 40 cases of laryngofissure for early intrinsic carcinoma of the larynx.*—This review has been undertaken to ascertain: (1) the features of those cases which are suitable for a successful laryngofissure; (2) the value of some modifications and details of the technique of the operation; (3) the results of the operation particularly in comparison with radium implantation, radiotherapy and complete laryngectomy.

It is recognized that the earlier the diagnosis the better and more lasting is the result of excision by laryngofissure.

The cases in which the growth is hard, keratinized and more or less limited to the middle or anterior third of the vocal cord are most suitable for excision by laryngofissure. The commonest site for an intrinsic epithelioma of the larynx is the vocal cord and the growth tends to extend horizontally to the anterior or posterior commissure. It may burrow under the surface of the cord. A few cases commence in the subglottic area usually near the anterior commissure and then involve the vocal cord. A slight extension upwards on to the ventricular band or into the ventricle does not make it unsuitable for successful excision. If the growth has extended to the subglottic area, the posterior commissure or across the anterior commissure with fixation of the cord it cannot be completely excised by laryngofissure. It must be remembered that the upper surface of the growth only is seen by the laryngoscopic mirror but any extension to the subglottic area though hidden can be suspected if there is any stridor, obstruction or fixation of the cord. It happens on a very few occasions that during the operation when the growth is thoroughly exposed it is found that the growth is more extensive than expected.

Gordon New of the Mayo Clinic has stated that cases which have had a laryngofissure are not such good cases for a subsequent complete laryngectomy but there is no objection to an exploratory operation by laryngofissure if there is considerable doubt as to its suitability. Direct laryngoscopy should be used in doubtful cases.

The large majority of epitheliomata can be diagnosed accurately without a biopsy. A biopsy of value demands that an adequate piece of the growth has been removed from the right place and presents a definite histological picture.

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Even then it is necessary to exclude tuberculosis and syphilis. It is in cases of obscure tuberculosis when the sputum is absent and when physical signs cannot be detected that a biopsy is necessary. The Mayo Clinic surgeons place considerable reliance on Broders' classification of malignancy by the histology of the section. Class 1 is comparatively benign and does not metastasize. Class 4 is very malignant. New records that all Class 4 cases found in 44 patients, in which the growth recurred after laryngectomy, died. 72 per cent. of StClair Thomson's Grade 4 cases recurred. Colledge and I have noticed that the surface of the section may be Class 1 but another and deeper part of the section may be Class 3 or 4. It is difficult even for the expert to be reasonably sure of his classification. Moreover a larger piece than can be obtained for biopsy is essential for an accurate classification. Most of my cases free from recurrence have been of the epidermal type with cell nests and probably Grade 1.

The anaesthesia I prefer is chloroform and ether administered by a soft small intratracheal tube. At the Mayo Clinic local anaesthesia is preferred. Five drops of a solution of cocaine injected with a hypodermic syringe through the cricothyroid membrane before splitting the thyroid cartilage results in a tranquil operation.

The isthmus of the thyroid gland was divided in all the cases so as to expose the trachea and to facilitate a tracheotomy should it be necessary. Tracheotomy has been avoided in the last 6 of the 40 cases and I now find that tracheotomy is undesirable and unnecessary. The intratracheal tube is completely reliable. As soon as the larynx has been opened the trachea is sealed by packing ribbon gauze around the intratracheal tube. This tube does not obscure the area of operation. It lies snugly on the posterior commissure and is not in any way cumbersome.

In the remaining 34 cases the tracheotomy tube was removed before the patient left the operating table and it was never necessary to replace it.

It is essential to see that the wound is absolutely dry before the larynx is closed. Oozing is arrested by a small button electrode with the weakest possible diathermy (shortest spark gap) or by the usual method of touching the artery forceps with a diathermy electrode. Those cases in which the growth was excised by the diathermy needle appeared to me to be more septic later and took longer to heal so I have given up excision by diathermy and use the knife or scissors. New seals the laryngeal wound lightly with a small button electrode with the weakest diathermy current to be effective. Some surgeons found it necessary to use a stitch ligature for the small arytenoid artery. Hajek and J. S. Fraser packed the larynx with gauze to prevent haemorrhage. The packing was removed the next day. This method is not recommended.

Division of the body of the hyoid bone adopted by New to allow the larynx to be drawn up into the wound and to facilitate access is unnecessary in my experience. Division of the hyoid bone causes pain and discomfort with the movement of the tongue on swallowing.

The saw, a rough surgical instrument, was not used at any time to divide the thyroid cartilage. There was never any difficulty in dividing the cartilage with the knife and Irwin Moore's shears.

I prefer to denude the thyroid alae by dissecting off the soft tissues and growth *en bloc* and not to remove the alae. The thyroid cartilage is a barrier

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to the spread of the growth. There has been no disadvantage when the thyroid alæ have been removed.

At the end of the operation the thyroid alæ are accurately replaced and the larynx closed by fine catgut stitches through the thyrohyoid and the cricothyroid membranes.

There were no deaths as the result of the operation in the 40 cases. The mortality in 41 operations performed by Gordon New was nil. It is interesting to note that in 1888 before the days of asepsis and antisepsis Morell Mackenzie reported 22 cases, 6 of whom died and 72 per cent. recurred.

Deep X-ray with teleradium (radium bomb) in my experience has been unsatisfactory. Burning of the skin and necrosis of the cartilage and even the rings of the trachea have caused misery to the patient. Two cases of early intrinsic carcinoma of the vocal cord treated by teleradium with recurrence after two years were treated by laryngofissure and were still without recurrence after five years.

Radium implantation gives the most beneficial dose at the right spot more accurately than any other method of radiotherapy but my experience of this technique is too small to be of any value.

*Laryngofissure*.—Gordon New : 41 cases, 13% recurrence. StClair Thomson : 60 cases, 25% recurrence. Davis : 9 no recurrence after five years and longer ; 5 recurred after two years ; 4 recent operations within two years ; 7 exploratory and unsuitable ; 15 cannot be traced.

*Laryngectomy*.—Mayo Clinic : 86 cases, 52% recurrence ; 8% immediate mortality.

*Radium implantation*.—Harmer (*personal communication*) : 24 early cases, 14 survived three years, 42% recurrence ; 72 advanced cases, 32 survived, 54% recurrence.

**LIONEL COLLEDGE** : Mr. Davis seems to think that I always excise the larynx. But there is no real contrast between laryngofissure and total excision of the larynx. The proper operation must be selected for each case. The operations to be employed are : laryngofissure, a partial excision which rather goes beyond the limits of strict laryngofissure, and total laryngectomy. I have already described the technique, most recently in the Lettsomian Lectures delivered before the Medical Society of London, and I do not think I need detain this meeting with detail, because I look upon the operations as more or less standardized.

There are some points in the remarks by Mr. Davis which call for comment. Whilst it is true, as he says, that in the majority of cases a correct diagnosis can be made without biopsy, it is equally certain that in this situation mistakes will be made in cases which appear to be epitheliomatous unless biopsy is done as a routine. He says that it is in obscure cases of tuberculosis that biopsy is needed, but it is just these cases that are missed unless routine biopsy is done, because this form of senile tuberculosis in the middle-aged or elderly mimics epithelioma very closely. The majority of mistaken diagnoses are due to confusion clinically between tuberculosis and epithelioma, much less often to syphilis but also to haematooma, innocent tumours and leukoplakia. The latter in my view is often precancerous and justifies laryngofissure. Biopsy is not only useful in providing a confirmation of the diagnosis,

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gives an indication of the degree of malignancy and therefore of prognosis from the surgical point of view, though at present it gives no information concerning radio-sensitivity. Any case of epithelioma in Group IV requires a very radical operation and is unsuitable for laryngofissure. Either total excision or radiotherapy by beam is the appropriate treatment. On the other hand there should be no exploratory laryngofissures, to which Mr. Davis says there is no objection. A sufficient clinical study of the case will provide the information upon which the appropriate operation can be chosen. Laryngofissure upon an unsuitable case is not necessarily a disaster, but may easily become one if the incision cuts into the tumour. In any case the best technique for the more radical operation is made impossible, and to convert the lesser procedure into the major one involves various technical difficulties.

The true tumours of the larynx, that is the intrinsic tumours which mostly arise on the vocal cords, with a few subglottic, in the ventricles or on the false cords, no longer offer any surgical problem, because appropriate operations are available for all situations and all stages short of gross extension beyond the confines of the larynx. These operations of laryngofissure, partial excision and total excision of the larynx may now be said to be standardized : the indications for each and the technique have been fully described (*Letsomian Lectures, Medical Society of London, 1943, in the press*), and they provide a good percentage of lasting results. Among earlier cases out of 23 cases of laryngofissure or partial laryngectomy 18 survived more than ten years, and out of 75 cases of laryngectomy 45 survived more than ten years. As the technique is now better than it was ten to twenty years ago, and these figures include the operative mortality, the outlook now should be better than this, which gives 63 per cent. freedom from recurrence for ten years, 78 per cent. for early cases, and 60 per cent. for later cases. This percentage is so high that any form of treatment designed to replace excision must show a good record of successful results, if alternative treatment can be justified. The problem at the moment is whether radiotherapy can safely be substituted as routine treatment for these forms of cancer in place of the operations mentioned. To make the comparison Dr. Lederman will say what can be expected from radiotherapy. There are, however, a few points which need attention, because they reflect on the advantages claimed for radiotherapy. It is often suggested that as radiotherapy is a non-mutilating form of treatment it should have the first chance, because if it fails operation can follow and may still succeed. There is some truth in this and I have many patients in whom operation has succeeded after failure by deep X-rays or radium, or even both, but unfortunately it is not the whole truth. Sometimes the tissue changes after irradiation are not severe, the operative technique is not much hampered and healing is not prolonged for more than a week or ten days beyond the usual period. In consequence an experience founded on a few cases can be very misleading and cause the adoption of a too optimistic view of this situation.

In only too many cases the changes in the neck cause dissections to be extremely difficult, especially gland dissections, healing is almost indefinitely prolonged, pharyngostomes form and plastic operations on the devitalized skin of the neck fail constantly. It may be necessary to bring skin from a distance by tube pedicle grafts and relatively simple plastic operations become long,

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tedious and uncertain, and at the worst sloughing and haemorrhage in the absence of the normal process of repair may destroy the patient. I do not think, therefore, that the statement that operation can follow irradiation is a valid argument for irradiation stated in that too simple form.

A further difficulty arises from the fact that the most attractive target for the radiotherapist is an early epithelioma of the cord, suitable for excision by laryngofissure. If the radiotherapist fails to cure, however, a total laryngectomy is required. I have now such a case in a robust middle-aged man who was treated by radium and then by deep X-rays. He remains well with a good pharyngeal voice after laryngectomy; but he has lost his larynx when he might have been cured by laryngofissure. On the other hand, a spare, elderly man came to me with an early epithelioma of one cord, very suitable technically for laryngofissure, but he has a high blood-pressure and has lost the sight of one eye from a detachment of the retina. These may not be absolute contraindications to operation, but I regard them as relative contra-indications when the alternative of radiotherapy is available. Dr. Lederman restored the larynx of this patient to a normal appearance, and so far it has remained so, but only a year has elapsed. In another case a well-preserved man over 80 has had a normal larynx for more than a year since an epithelioma of the anterior commissure disappeared under the influence of teleradium. I particularly mention these early cases which provide a brilliant success to the radiotherapist, because the more the growth has advanced the more difficult becomes his task and the greater the percentage of failures. Consequently radiotherapy is not complementary to excision, but is only an alternative method. In other words, radiotherapy is a much more efficient substitute for laryngofissure than it is for laryngectomy, which is naturally the more mutilating operation. I feel, therefore, that whilst selected cases should be treated by radiotherapy, it is not right to treat all cases as a routine by radiotherapy and operate afterwards on the failures. Biopsy does not help to distinguish the tumours which are likely to prove failures from those that are radio-sensitive, and the therapeutic test which has been proposed by Nielsen and Strandberg, 1942, *Acta radiol. Stockh.*, xxiii, 189, and Cutler, Max, 1944, *Arch. Otolaryng.*, Chicago, xxxix, 53, seems to me to indicate a half-hearted, undecided attitude. It is still necessary to consider each case as a whole and then decide whether to recommend excision or radiotherapy for that individual.

Finally, the time has passed for burying needles in the neck. If radiotherapy is employed it should always be by means of the teleradium beam, which can now be adjusted to such accurate dosage that the risk of radionecrosis is very small, provided the patient is protected from minor injuries locally.

M. LEDERMAN: *Treatment by radiation of the so-called intrinsic cancers of the larynx*, that is, primary squamous cancer arising from: (1) The ventricle, the false cord, and the base of the epiglottis; (2) the true cord; (3) the subglottic region. Extrinsic cancers have been excluded because they are pharyngeal in origin and require an entirely different radiotherapeutic approach.

Two main radiotherapeutic methods are available for treating intrinsic cancer: (1) The use of radium either alone or in combination with surgery, e.g. teleradium or the Finzi-Harmer operation. (2) The use of X-ray therapy

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either alone or in association with surgery, e.g. high voltage therapy or the Lambert-Watson operation, which is roughly the X-ray counterpart of the Finzi-Harmer operation.

A combination of high voltage X-ray therapy and teleradium finds favour at some centres. The intralaryngeal use of radium either by intubation or implantation of radon seeds and the use of surface radium moulds are to be condemned.

The Finzi-Harmer and the Lambert-Watson procedures find their greatest field of usefulness in the treatment of early lesions of the vocal cord, i.e. the type of case for which the laryngofissure operation is available. High voltage therapy or teleradium can be used for similar cases as well as the more advanced cases which surgically would demand partial or total laryngectomy.

Whilst the Lambert-Watson procedure is too recent for its value to be assessed, the Finzi-Harmer operation represents a definite landmark in the history of radiation treatment of endolaryngeal cancer, and its value has been established beyond all reasonable doubt. Nevertheless, I believe that external radiation by teleradium or high voltage X-ray therapy can and probably will supplant this method, for the following reasons : (1) The results obtained by external radiation for comparable cases are as good without any operative risk ; (2) on physical grounds external methods are more efficient and safer ; (3) individualization of treatment is the keystone of success when dealing with a group of tumours of variable and unpredictable radio-sensitivity. The necessary degree of individualization is only possible with external radiation, where the treatment can be clinically adapted to a particular patient's requirements, in contrast to the Finzi-Harmer method where the patient has to be submitted to a fairly rigid technique.

Fundamentally the only difference between gamma rays and X-rays is one of wavelength, and whether the short wavelength  $\gamma$ -rays differ from the longer wavelength X-rays in their biological effect on malignant tissues is still not definitely known. Upon purely clinical grounds I am convinced that normal tissues, dose for dose, show less change with teleradium than with X-ray therapy under ordinary conditions of treatment. This may, however, be due to the different dosage-rates employed rather than to any difference in wavelength. Certain differences of apparatus and physical conditions of treatment endow teleradium therapy with greater technical precision and flexibility and permit greater individualization of treatment than is the case with X-ray therapy.

For the individual case of intrinsic carcinoma of the larynx the selection of treatment method as between surgery and radiotherapy is difficult. Whilst it is obvious that there is need for both methods if all patients are to receive the best treatment, there is a diversity of opinion concerning the precise indications for each method. Any attempt made to solve this problem must take into account the following considerations.

*General condition of the patient.*—Age and general condition do not limit radiotherapy to the same extent as surgery. The modern treatment of laryngeal cancer is one of the mildest of all curative radiotherapeutic procedures. Correctly administered treatment should not give rise to any general constitutional upset, and local symptoms need rarely exceed increased huskiness accompanied by slight soreness or dryness of the throat. Severe dysphagia

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or marked skin reactions should not occur, and in most cases oedema of the larynx is avoidable.

*Purpose of treatment.*—If on any grounds, either general or local, curative treatment is out of the question it is evident that radiotherapy can offer more than surgery. The only palliative procedure available to the surgeon is tracheotomy, whereas the radiotherapist can often relieve distressing symptoms and prolong the life of the patient in reasonable comfort. Frequently the assistance of both is required.

*Histology of the tumour.*—It is not uncommon to find, particularly in American literature, considerable importance attached to the histological grading of squamous cancer. This method of grading is of some value in assessing the degree of malignancy and also the method of treatment in so far as the more anaplastic types, i.e. Grades III and IV, are usually biologically inoperable even when technically operable. Grading may also assist in prognosis, but it provides little guide to radio-sensitivity, since anaplastic carcinomata are not necessarily, as is often assumed, more radio-sensitive than differentiated carcinomata.

*Extent and site of the disease.*—The extent of the disease is clearly of paramount importance in selecting treatment. The degree of laryngeal extension and the presence of extralaryngeal spread or metastases will frequently decide whether surgery or radiotherapy is to be employed, and, in the case of the latter method, whether treatment is to be purely palliative or not.

Site is equally of importance since supraglottic neoplasms, arising from the ventricle, the false cord or the base of the epiglottis, tend to be most, and the subglottic neoplasms least, radio-sensitive, with tumours of the true cord showing an intermediate and moderate degree of radio-sensitivity. Hautant recommends radiotherapy for most of the supraglottic, and laryngectomy for some of the ventricular and all the subglottic neoplasms. Although experience proves that the supraglottic tumours are a satisfactory group to treat by radiotherapy, opinions as to the suitability of the subglottic group for radiotherapeutic treatment should be accepted with reserve until radiotherapists are given greater opportunities of treating them. It is the common tumour of the true cord which presents the greatest problem. I believe that cancer of the true cord should always be treated by radiotherapy, with the exception of the more advanced and some of the recurrent cases. A certain number of advanced cases showing fixation of the cord can be cured by radiotherapy, but the presence of infiltrated cartilage reduces the prospects of cure, whilst a complicating septic perichondritis is an absolute contra-indication to radiation.

Where doubt exists as to the best method of treatment trial radiation is justifiable. By this means it is possible to determine approximately whether a particular tumour will or will not respond before a full course of treatment is given, and if necessary surgery can be undertaken before marked radiation changes occur in the tissues. Features suggesting that radiotherapeutic treatment should be abandoned or given for palliative purposes only are : (a) Poor response of the primary lesion, or no improvement of symptoms such as dyspnoea and stridor at the end of half the course of treatment—roughly three weeks. (b) A laryngeal oedema which fails to subside during treatment, or an oedema arising early in treatment and persisting. (c) Local septic

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complications as shown by : (i) Persistent pyrexia in the absence of an extra-laryngeal focus of infection ; (ii) the onset during treatment, or persistence, of foctor ; (iii) perilaryngeal abscess. (d) Any deterioration of the patient's general condition, particularly loss of weight in the absence of dysphagia.

It is difficult to lay down any hard and fast rules for the treatment of recurrent cases. For local and scar recurrences after excisional surgery radiotherapy is useful as a palliative agent and sometimes effects a cure. We have had more success with post-laryngectomy recurrences than with those following laryngofissure : radical surgery should be considered for the latter if the aim is cure rather than palliation.

For local recurrences after radiotherapy it can be stated quite categorically that further radiotherapy has many dangers and only infrequently results in cure : wherever possible these cases should be treated surgically ; failing this radiotherapy can be undertaken as a palliative treatment.

The best way of dealing with cervical lymph-node metastases is as yet undecided. In a previously untreated neck I recommend teleradium as the primary method of attack in both operable and inoperable cases, surgery being retained as a second string. If metastases occur in a previously treated neck, surgery should, if possible, be the first choice and radiotherapy reserved for cases unsuitable for this method. Any claim made for the wide use of radiotherapy in the treatment of operable intrinsic laryngeal cancer, to be acceptable, must be based upon the results obtained. It is therefore of the utmost importance that the following facts be given due consideration when attempting to assess and compare radiotherapeutic results with those of surgery :

(1) Surgical skill and technique in the performance of the various laryngeal operations for cancer have reached their peak of efficiency and it is unlikely that any further developments of technique will produce much improvement in results. By comparison radiotherapeutic treatment is still in process of development and has, in fact, only recently emerged from that dismal stage wherein laryngeal surgery found itself fifty years ago.

(2) Figures emanating from surgical sources are selected figures since only cases operated on are recorded. To obtain an accurate picture of the true value of the method as much attention should be given to the number of cases found unsuitable for surgery as to the cases successfully treated.

(3) The radiotherapist has to be content to base his results largely on material discarded by the surgeon. A true comparison of results will only be possible when the radiotherapist's material is comparable.

(4) There is no statistical method of showing the two great advantages of radiotherapy over surgery, namely, conservation of the larynx and the absence of an operative mortality.

The results of surgery are on the whole very good and are a credit to surgical skill and achievement. In Mr. Colledge's series, for example, 70 per cent. and 60 per cent. ten years' survival rates set the radiotherapist a very high standard for emulation but the operative mortality and recurrence rate for most published series are not negligible.

I believe that Tables I, II and III provide enough evidence to show that for the early cases, i.e. those suitable for laryngofissure or hemilaryngectomy, radiotherapy can offer the patient as much as surgery with less risk. Similarly

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for the more advanced cases where laryngectomy is the operation of choice radiotherapy can successfully compete with surgery in an appreciable proportion of the cases, but there will always be a certain number of patients who will have to sacrifice the larynx to save life. For the inoperable cases radiotherapy is of palliative value and shows on the whole a worth-while salvage rate.

The figures also show that radiotherapy results are durable. My own experience leads me to believe that the case that does well initially remains well, i.e. the recurrence rate is not high, certainly less than that following surgery.

The radiotherapist is dependent on his surgical colleagues for material and unless he is adequately supplied with suitable cases radiotherapeutic progress is bound to be painfully slow. The problem of the "relative spheres of interest" of radiotherapy and surgery could be settled within the next decade were the radiotherapist enabled to explore fully all the promising potentialities that radiotherapy possesses.

Slides were shown illustrating radiation reactions, results of radiation treatment and types of case both suitable and unsuitable for radiotherapy.

TABLE I—RESULTS OF RADIOTHERAPEUTIC TREATMENT

Author	No of cases	Material	Survival rate	Period of observation
Coutard (1921-32)	143	Precise details not stated Mostly inoperable and post operative recurrences	39-27%	5 years
Schintz and Zuppinger (1929-35)	33	Operable and inoperable	4/14 = 28%	5 years
Nielsen and Strandberg (1931-40)	63	Operable 20 Inoperable 43	6/10 = 65% 8/32 = 25%	3 years
Cutler (1938-43)	..	84 All cases Cord tumours Mobile Partly fixed Fixed	31/84 = 37% 23/28 = 82% 0/12 = 0% 40	3 years
Blady and Chamberlain (1931-37)	23	No precise details but of 11 patients with cord fixation 5 survived 5 years	23/40 = 57% 13/23 = 67%	5 years

TABLE II—CASES TREATED AT THE ROYAL CANCER HOSPITAL (1933-1944 INCLUSIVE)

Total cases	Material	Survivals	Disease present	Untraced	Inter-current disease
All cases seen were treated Teleradium used exclusively	Operable 23 Inoperable 19 Recurrent 14	8 5 years or more 18 15 5 years 5	3	1	—
		x 5 years or more			

TABLE III—ROYAL CANCER HOSPITAL OPERABLE CASES TREATED BY TELERADIUM THERAPY

Operation	No of cases	Result
Suitable for Laryngolâsire Partial laryngectomy	4 } 8 (5 patients between 72-79 years of age)	All patients initially symptom free 6 living and symptom free 2 for 5 years or more 1 for 2-3 years 3 for x-2 years 1 patient died of intercurrent disease 1 patient untraced
Suitable for laryngectomy	15	12 living and symptom free, 6 for 5 years or more

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Lieutenant-Colonel W. L. HARNETT (Medical Secretary to the Clinical Cancer Research Committee of the British Empire Cancer Campaign) brought forward some as yet unpublished figures concerning 123 cases of cancer of the intrinsic larynx. There were 113 males and 10 females, a sex ratio which was in accord with general experience. The mean age in both sexes was 62. On a clinical classification there were 57 early cases, in which the disease was confined to the larynx, 63 advanced cases in which it had spread to the surrounding tissues, with or without metastases in regional lymph nodes, and 3 cases in which there were distant metastases. Of the 57 early cases, 15 were treated by radical surgery, of whom 13 were alive after four years, 19 by radium of whom 8 were alive, 13 by X-rays of whom 4 were alive and 10 by palliative methods, all of whom were dead. The operation mortality for laryngofissure (12 cases) was 8·3 per cent., for laryngectomy (3 cases) nil. Of the 66 patients in the later stages all except 5 were dead.

E. MUSGRAVE WOODMAN said that he did not agree with Mr. Colledge that to bury needles in the neck was an anachronism. He followed Mr. Douglas Harmer in using needles with the window method for the treatment of carcinoma of the vocal cord. It was unfortunate that Mr. Harmer had not been able to be present because that particular method of application had not been presented. Carcinoma of the vocal cord itself could be cured by operation or by radiotherapy. Excellent results were obtainable with laryngofissure, and Mr. Harmer had obtained excellent results with radium therapy. The speaker had hitherto followed the method of inserting radium needles through the window in the larynx, and if necessary following it up with X-radiation through the port thus made. The results had entirely satisfied him.

Even if the result with radiotherapy was constantly no better than that with surgery they must, in fairness to their patients, use radiotherapy because it restored the larynx to the condition in which it was before; in other words, the patient had a good voice, whereas with the best of operations there was a defective voice. He had been rather disturbed by the inefficient result of radium on growths in the sac of the larynx and at the base of the false cords. In his experience not one such case had done well with radium or teleradium, but such cases should be sharply separated from primary growths of the cord, and should

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be first subjected to surgery as the method of choice followed later, if necessary, by radiotherapy.

Mr. Colledge had been a pioneer in laryngectomy, and his results were excellent. But it was rather difficult to persuade a patient to give up his larynx and to be told that he would never speak again. If any method could be found which would remove that unpleasant necessity they would all be pleased.

He had been interested in one of Mr. Davis's cases which had died of carcinoma of the oesophagus. One of his own best cases had an extensive growth in the larynx and pharynx. He had had to take out the larynx and pharynx, but the patient lived for ten years and then developed cancer of the oesophagus and died therefrom.

N. S. FINZI said that when they saw a patient with an intrinsic growth of the larynx the best thing they could do was to put themselves in his position, and, knowing all they did about the various treatments, imagine what they would desire in their own case. As to growths which were suitable for laryngofissure, they had to consider the patient's life first rather than his voice. There was no question about the effect on the voice ; Mr. Harmer had had gramophone records of voices made, and the comparison between even the best "laryngofissure voice" and the average "radium voice" was very striking. Some of Mr. Harmer's cases had survived for over twenty years.

From what Mr. Lederman had said it looked as if teleradium was going to give better results than radium implantation. If subsequent operation were necessary, however, the cases in which implantation had been used would not give anything like the difficulty which might be expected in cases receiving external radiation. On the other hand, if anything like as good results could be obtained with external radiation, this should be given.

Treatment by radium in former times did not afford such good results as were obtainable when individual treatment was developed later. He thought there was likely to be further improvement in results now that sepsis could be so largely eliminated. Though operations were sometimes necessary for the failed cases of radium and X-ray treatment, there were also, of course, the failures of surgery with which radiotherapists had to deal.

The speaker suggested that Mr. Davis might have got better results if he had had these cases heavily irradiated after laryngofissure in order to prevent that small percentage of recurrences in those cases where he had failed to remove the growth completely. Mr. Lederman had shown some cases where there was an unexpectedly large spread of the growth beyond that visible with the laryngoscope and he had himself seen some of these cases. Perhaps it might help to eliminate some of the errors if a skiagram of the soft tissues were taken before treatment was started.

V. E. NEGUS said that about five years ago the late Sir StClair Thomson and himself started to write another edition of the textbook, and now, after Sir StClair's death, he was left to carry on that struggle alone. It was very difficult in editing such a book to form conclusions as to the right treatment of certain diseases of the nose and throat. He had found this particularly when endeavouring to decide what was best for a patient who had carcinoma of the larynx. If they could get patients cured by radiotherapy, with a normal voice afterwards, instead of by operation, with a somewhat hoarse voice, they

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should certainly do so ; but he had had a certain number of patients with a type of growth which might be expected to respond to radiotherapy who came back with recriminations because they had been subjected to that procedure. He warned patients that they must not expect that they were going to get off lightly by avoiding an operation and having radiotherapy instead. Some patients said afterwards that they had suffered considerably as a result of the prolonged treatment and the reaction ; he had not had the same recriminations in the case of patients on whom he had operated.

In a few cases patients a year or two later had perichondritis after external radiation. (He was talking rather about deep therapy, not teleradium, but he understood that there was not very much difference between the two methods.) Those cases were very depressing. If a patient had a growth of low-grade malignancy and of suitable distribution, he would at present recommend laryngofissure because of these reactions. If irradiation technique improved, and these subsequent reactions were avoided, he might alter his opinions.

He did not think that laryngectomy was a difficult or dangerous operation, but he had found difficulty with a considerable number of patients in getting them to adapt themselves to their life afterwards. The hypertrophic laryngitis which went on to carcinoma should be treated by operation and so should cases with perichondritis. But if there were a carcinoma along the whole of one cord, extending to the posterior commissure, when surgical treatment would necessitate laryngectomy, the patient might be given the chance of radiation treatment. He had been told on the authority of radiotherapists that it was more scientific to use external radiation, but certainly the cases he had treated by implanting radium needles by the Finzi-Harmer method had done very well. They had a brief time in bed, with little suffering, and they had the advantage of the removal of the cartilage so that there was no irradiation through the cartilage, and there should therefore be no perichondritis.

C. P. WILSON said that though he had had the advantage of being associated with a first-class radiotherapeutic department, he had never seen radiotherapeutic results as good as those he had just heard about, nor had he ever seen surgical results which approached the results one heard about.

From the statistical point of view it would be interesting if some of their statisticians could take the figures which had been given by the first three openers and set them out on the basis which Colonel Harnett had given.

Concerning surgery following radiation there was one point he desired to make, namely, that surgery should never be attempted after a patient had had more than one course of radiation. From his own limited experience he would say that surgery was quite impracticable when there had been extensive radiotherapy. From the point of view of assessing cases suitable for one or other method of treatment he did not think they could go further than Mr. Negus had already gone. He knew of no method by which the cases likely to prove radio-sensitive could be assessed with any degree of probability.

L. GRAHAM BROWN said that he had seen a great number of cases of carcinoma of the larynx, but he had confined his operative procedure to simple carcinoma of the cord, preferring to refer other cases to radiation.

They were agreed that laryngofissure was a simple operation and a very

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successful one. Concerning the other cases, considerable differences were noted ; sometimes the result was marvellous and at other times most depressing, but he thought that there was a great future for radiotherapy in these cases. It depended a great deal on whether they could get proper standardization of treatment.

He remembered in that Section some years ago drawing the fire of the late Sir StClair Thomson because he had not done a preliminary tracheotomy in cases of laryngofissure. He thought that with the great advance in technique, with the added benefits of intubation, and also with the use of the diathermy or cautery point, bleeding could be sufficiently controlled to get a dry field often without preliminary tracheotomy. He thought that this practice applied also in America to a considerable extent. A tracheotomy did retard the convalescence. In a recent case, after performing a successful operation of laryngofissure, feeling he should give the patient the benefit of the doubt, he sent him for a course of radiation. Unfortunately, although the patient made a quick recovery from the operation, he suffered for months afterwards from the radiation treatment.

Colonel N. CANFIELD (U.S.A.M.C.) said that he wished to mention that their war surgery during the last six months had shown the value of tracheotomy in treating wounds of the larynx, pharynx and jaws. Tracheotomy diminished the muscular action of the pharynx and larynx and these cases healed very much better. He thought this might possibly apply to cases in which a tracheotomy had been performed in preparation for laryngofissure.

E. D. D. DAVIS, in reply, said that the Harmer-Finzi operation appealed to him because it gave the right dose at the right spot. Mr. Harmer and his colleagues had worked out the technique very thoroughly. Teleradium and X-ray therapy produced burning and considerable skin irritation and discomfort. Two cases of laryngofissure in which it was thought the growth had not been completely eradicated were given teleradium as a prophylactic treatment. Both patients died of secondary growths of the liver within twelve months.

LIONEL COLLEDGE, also in reply, said that he had been sorry to hear that Mr. Musgrave Woodman was so "reactionary" on the subject of treatment by radium needles. It could not be anything like so scientifically accurate as teleradium, and the results which Dr. Lederman now obtained showed that teleradium treatment produced everything, in selected cases, that could be produced by other procedures. On the other hand, Dr. Lederman and Professor Mayneord have shown that if radium needles be used as the source of irradiation in the larynx the distribution in the horizontal plane shows a region of heavy irradiation at the anterior commissure, but falling off rapidly along the cord in the direction of the arytenoid cartilage. Morton, Gray and Neary also found by physical measurements that by the usual method of employing needles the anterior part of the larynx receives twice the dosage that reaches the posterior part. Therefore it is only a very small tumour which can receive a homogeneous dosage.

Much had been said about the loss of voice following laryngectomy. But this loss was not complete, and in some cases the patients held their own very well. He had in mind a solicitor, aged about 50, who had managed to conceal

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from everybody except his own doctor the fact that his larynx had been excised. He was a little husky, but no one in his own town knew that he had undergone an operation. With the co-operation of a speech therapist, the speech difficulty was no longer to be accounted among the disadvantages of the operation.

Dr. Finzi had suggested that the operations which followed radiation were more difficult if teleradium had been used than if the radiation had been applied by means of needles. On the other hand, there was a good deal of scarring in the neck if needles had been implanted, and, worse still, the cartilage on one side had been removed prior to the spread of the tumour. It had been his experience that operations had been more difficult after needling than after external radiation.

Mr. Graham Brown and some others were inclined to condemn tracheotomy as a first step. But in laryngofissure now and then the patient did bleed severely a few hours after the operation, and tracheotomy was a safeguard.

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T. B. JOBSON asked whether Dr. Lederman was of opinion that the preliminary removal of cartilage on the side of the growth would increase the penetrative power of the rays and lessen certain risks.

M. LEDERMAN, in reply, said that in his view the removal of the cartilage would not be of any value and would certainly not affect the penetrating power of gamma radiation. Hautant in Paris at one time removed part of the thyroid cartilage, but the procedure had since been given up.

Replying to other points in the discussion, Dr. Lederman said that Dr. Finzi had mentioned the expediency of taking a soft tissue skiagram in these cases. That was done, plus tomography, in the cases he had described.

Mr. Negus and Mr. Davis had mentioned reactions. He had been at some pains to investigate this point. With teleradium the reactions were never as bad as had been supposed.

External radiation was the only method whereby the right dose could be introduced to the right spot. The whole weakness of the Finzi-Harmer method was that there was a tendency for a very large dose to be delivered to the anterior commissure, and only half that dose to the region of the posterior end of the cord.



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## REFLECTIONS ON THE RADICAL MASTOID OPERATION

WITH A DESCRIPTION OF THE TECHNIQUE EVOLVED  
FROM MY EXPERIENCE

By B. SEYMOUR JONES (Towyn)

Two of my colleagues have written to invite me to write an article describing the method I used at the Birmingham and Midland Ear, Nose and Throat Hospital for obtaining complete and permanent resolution of discharge after a radical mastoid operation had been performed.

They have asked that the exact operative technique should be described in full detail.

If this communication proves of interest to my colleagues I am amply repaid.

The ill-repute in which the radical mastoid operation is held by the general practitioner, arises from the subsequent persistence of the discharge, and the creation of an unsightly orifice, displaying the anatomy of the middle ear and mastoid.

Surely this is a reproach to our craft ; we should amend our methods. There is no logical reason why every radical mastoid should not be freed from any discharge, and present a creditable cosmetic result which does not advertise the patient's affliction. My target throughout the passing years has always been these two objectives, arrest of the discharge and a good cosmetic appearance.

Many methods have been tried and discarded, many apparently well conceived artifices have been abandoned because of discovered flaws.

### Skin Grafting of Mastoids

In 1902 when I was H.S. to the late Sir Charles Ballance I assisted him at many radical mastoid operations. He was in the habit of applying

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a Thiersch graft to the granulating mastoid cavity some eight days after the operation re-opening the cavity for the purpose. Later we Otologists practised primary skin grafting in which Thiersch grafts were tamponed on the raw bone surface at the time of the operation with worsted or ribbon gauze. I grafted a great number of my early mastoids, and became very dexterous and successful at the technique.

Worsted impregnated with liquid BIP yielded excellent results ; this is removed on the fourth day, and no further packing should be inserted as it invariably destroys the sodden graft. All small elevations should be pricked and serum evacuated. Liquid BIP is then poured in with a teaspoon and the cavity examined in a week.

In cutting the graft, always vaseline the underside of the razor as this allows it to slide more easily, and only cut towards the operator from his left to right. One word of caution may be interposed here. Do not graft a very septic, diploetic type of mastoid ; a sinus thrombosis may supervene.

A prolonged survey of my mastoid cases over many years, and a close study of the eventual result induced me to abandon skin grafting almost entirely.

The major reason was, that grafted cases seemed to exhibit an increased tendency to exfoliation of the squamous epithelium lining the bony walls and eventually gave rise to desquamation and later to cholesteatomatous formation with further bone erosion after a year or two, if not very regularly supervised.

I now hold that we should not apply squamous epithelium directly to raw bone, as the lime salts in the latter stimulate the epithelium to excessive proliferation and cholesterol deposit in the cells.

I have come to the conclusion that there should always be a mattress of connective tissue or periosteum interposed between the new skin lining and the bone. I do not concur with the theory of metaplasia of columnar ciliated cells into squamous epithelium but regard cholesteatoma as an invasive pressure bone absorptive process.

Minute plaques of shining squamous epithelium can often be observed on the head of the malleus where the ciliated epithelium has been subjected to pressure by a cholesteatomatous concretion and replaced by squamous epithelium.

The two most revealing cases in my series of radical mastoids on this subject exemplified this invasive process. Both were private cases and had a small dry attic perforation through which a pearly mass of cholesteatoma presented. They were both referred to me with slight facial paresis on the left side. The one was a youth of eighteen and the other a woman of fifty-three. In both, a dry small mass of cholesteatoma was discovered in the attic, the mastoids were pervaded by dry elongated trabeculae of cholesteatoma which criss-crossed and penetrated to the

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posterior fossa of the cranial cavity and were in actual contact with the lateral lobes of the cerebellum, having eroded the posterior fossa dura. Each patient was unconscious for two days after the operation, and had a considerable leakage of cerebrospinal fluid. They subsequently made perfect recoveries.

The objections already raised to skin grafting led me to abandon the use of the commonly used plastic procedures on the external auditory meatus, and the necessity for providing a healthy granulation tissue bed led me to devise the fashioning of a large upper flap from the cutaneo-periosteal lining of the external auditory canal. The cogent reason underlying the construction of this flap is my experience that there is constituted by the operation, what I term a critical area between the new raw roof of the cavity and the facial ridge. The aditus ad antrum and the dense bone around the external horizontal semicircular canal are often slightly but imperceptibly carious owing to the continuous bath of pus to which they are subjected. This area cannot be curetted and is always the most obstinately secretory. The raw bone of the roof throws down dense fibrous tissue and callus, and the facial ridge likewise throws it upwards. Fibrous union then takes place and a tunnel is established from which pus continually oozes and this may leave the patient with a persistent headache and a most disgruntled outlook.

This residual infection may give rise to further extension of the diseased process and intracranial complications. I have recently seen a temporo-sphenoidal abscess develop as a direct sequel to this chronic infection.

By the manœuvre I am describing of turning a large flap upwards, the roof of the cavity and any exposed dura are covered and do not further exhibit hyperplastic down growth.

A number of cases of radical mastoid operations in soldiers have recently been seen by me at the Towyn Hospital which present this tunnel disability. It is difficult to treat and requires prolonged packing after cutting the overhang away.

There are also certain cases due to some constitutional diathesis which try the patience both of the surgeon and the patient.

Eczema subjects are a distinct problem, they throw off all skin grafts, are allergic to boric powder, and weep for a considerable time after its use, before resolving again. Unfortunately quite a percentage have a very contracted meatus, and consequently an upper flap is impracticable. They eventually heal when treated by prolonged packing with bismuth or zeroform gauze.

Cases of keloid in the radical cavity are fortunately very rare. Two examples of this obscure sequel were witnessed by me. Both were in girls from sixteen to eighteen years of age. In addition to the hyperplasia of the external scar, the whole resected mastoid cavity became

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filled with dense fibrous tissue. The first case was re-opened and scar tissue curetted away, but recurrence of the pathological process took place. It is interesting to note that the exuberant overgrowth is not limited to the skin, but affects the bone likewise. After a year they recessed to a limited degree.

Diabetic mastoids in my experience are not more obstinate than others in healing, provided the condition is recognized and insulin given. They are peculiar inasmuch as severe caries or complete necrosis of the mastoid can take place without any perforation of the drum membrane. I have seen two examples of this which simulated furuncle.

Tuberculous mastoids are my despair, the process is so deep seated that permanent cure is often a mirage. Very few of us have great experience of this affection in the mastoid, but for these I would advocate a larger opening in the meatus than is outlined in the ensuing pages.\*

I will now detail the successive stages of the operation in an ideal case, that is one without a fistula in the mastoid or acute inflammation of the soft tissues.

After the usual preparation the tip of the mastoid is first orientated with the left forefinger and a curved incision is made upward from this point about three-eighth inch behind and parallel to the cephaloauricular sulcus. This incision is then joined by an incision commencing above and in front of the auricle but a trifle closer to it. If a slight angle results, so much the better, as the suturing is rendered much easier with this landmark. The auricle is then dissected forward leaving a little connective tissue and fat attached to the subjacent periosteum. The periosteum is also exposed for a short distance at the posterior margin of the incision in the self-same manner. After ligation of bleeding vessels and insertion of a spring retractor, the whole upper and posterior aspect of the cutaneo-periosteal tube of the external meatus are detached from the osseous canal, at first with a blunt tonsil dissector, and the deeper parts of the sleeve by pushing half inch ribbon gauze down. Around the suprameatal spine, a scalpel may have to be invoked.

The detachment must be meticulously carried out as far down as the drumhead, for even the thin inner section is of cardinal value in subsequently covering the roof of the mastoid cavity. The ribbon gauze is then left in situ to protect the future flap and to arrest haemorrhage. The next step is to define the periosteal flap. A transverse incision is made through the periosteum at the lower border of the temporal muscle. From the ends of this, two parallel incisions course downwards as far as is practicable, the anterior skirting the entrance to

\* The author has recently done a radical mastoid in a female child of nine years old from which a large black sequestrum was removed—the cavity discharged for two years but by the use of silver nitrate 8 per cent. solution at 6 weeks intervals followed by insufflation of Pulv. ac. Bor. and Resublimated Iodine—the basic infection seems cured and it is completely dry.

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the osseous meatus, while the posterior is made as far back as possible. The flap of periosteum thus delimited is elevated from above downwards and left hanging down. A strip of ribbon gauze should be wrapped around it and damped with saline from time to time to prevent it from drying. The mastoid process is then dealt with faithfully.

I prefer the Vienna method of approach, by commencing with the use of a gouge around the suprameatal spine and working upwards and downwards and backwards. I find it much safer and more dependable than the method of searching for the antrum ab initio from a posterior hole. If the dura is exposed during the operation, no alarm need be felt, as I have never seen an infection of the meninges result, but I would recommend that all debris and discharge should be washed out as soon

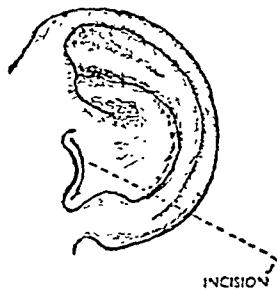


FIG. 1.

External aspect of auricle showing site of preliminary linear incision which should be strictly limited to the loose integument.

as the antrum is exposed, with a solution of one-eighthieth carbolic acid as a safeguard. The outer wall of the attic must be chiselled down until the roof of the resulting cavity is quite smooth. This is a sine qua non for the even application of the upper flap. It need not be exactly perpendicular, as in some very deep mastoid cavities the dura on the external side descends below the level of the upper part of the tympanic ring, and in this procedure I always use the Stacke protector from the external canal backwards when removing the bridge, and after removal of the bridge for taking down the outer wall of the epitympanum. The instrument I have devised has proved of great service in the procedure.

The question whether any form of bridge should be left between the facial ridge and the roof must be answered in the negative. Experiments in this direction in my early mastoids show the futility of it, as cholesteatomatous patches and caries in the incus and head of the malleus and around the aditus ad antrum prolong the discharge indefinitely and defeat the aim of the operation.

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### Removal of the Ossicles and Closure of the Eustachian Tube Orifice

It is an indubitable fact that complete ablation of the ossicles and closure of the eustachian tube yield the best results from the point of view of securing a perfectly dry cavity. There is a modern trend of opinion in favour of conserving the ossicles. The surgeon must decide the question of whether to preserve the remnants of the drum and ossicles for himself, weighing the amount of residual hearing in that ear and the other ear against the increased risk of re-infection through a patent Eustachian tube.

I suggest it might be a practicable measure to obliterate the isthmus of the Eustachian tube by a cautery point passed up a catheter. A number of discharging mastoids have recently been seen by me in which the tubal orifice was obviously patent. For rasping of the mucous

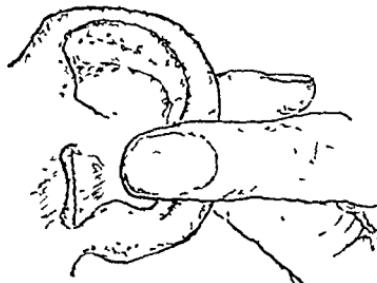


FIG. 2.

Entrance to meatus thrown into a straight fold by pressing forward with thumb and forefinger with line of incision just behind the fold When it is released it is a curved incision

lining of the Eustachian opening and effecting closure of it, an instrument is used having a file at one end and a small spoon at the other.

In cases where there exists a large attic perforation and an intact lower tympanic membrane I do not interfere with the membrane, but remove the remains of the carious incus.

#### Formation of the Large Upper Flap

The meatal skin is first sterilized by a strip of gauze soaked in tincture of iodine, and passed down the external canal. This is then removed and the auricle is then grasped by the left forefinger and thumb and pushed forward; by this manœuvre the posterior wall of the meatus is seen when looking into the external canal to double up on itself in a straight line. A sharp pointed tenotomy is then used to make a superficial incision strictly through the loose skin along this line thus thrown into prominence, or just behind it. In patients with small meati or in

## Reflections on the Radical Mastoid Operation

children, the incision will need to be made considerably external to the knuckled up margin. With the auricle held upwards, through the centre of this incision and in its line, the tenotome is stabbed from the lumen of the meatus through the cartilage and soft tissues to emerge at the back. A blunt tenotome is then substituted and the cut is enlarged upwards and downwards along the skin incision in the posterior meatal wall. By this method an accurate and correctly gauged opening can be secured. The ear is then turned forwards and the incision through the soft tissues carried well up and down. The points of a large Spencer Wells artery forceps are next threaded through the aperture from behind forwards, and pushed down the cutaneo-periosteal cuff and held by an assistant, in such a way that a little leverage is exerted. The redundant cartilage and connective tissue thus thrown in relief are pared away until the cuff is as thin as possible. Care must be taken not to

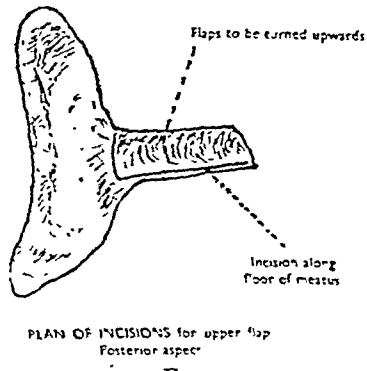


FIG. 3.

Posterior aspect of auricle and tube of the meatus showing plan of incisions at entrance to meatus and along floor of meatus.

button hole the flap, and at this stage a Bard Parker knife, and sharp curved scissors are used for this attenuation. The flap is then completed by cutting along the floor of the meatus at absolutely the lowest possible point, and a slight ancillary cut may be made downwards and forwards as shown in Fig. 6. The flap is then turned upwards and stretched along the roof of the mastoid cavity and tethered to the fascia over the temporal muscle by an absorbable catgut suture, a round intestinal needle being employed.

After beveling off the sharp underlying edge of bone to permit a slanting bed, the periosteal flap is spread in the excavated groove of the mastoid (Fig. 4). This flap must on no account cover the facial ridge, for if it does so it will narrow the meatal canal too much by hyperplasia. The radical cavity is then packed tightly with ribbon gauze immersed in liquid BIP, and the end of this gauze is brought out through the meatal

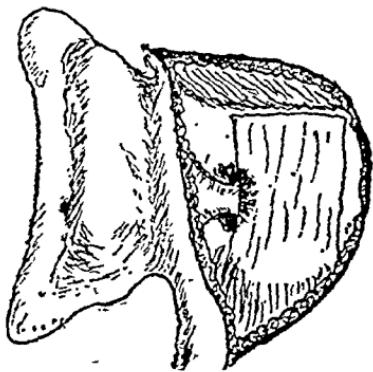
## B. Seymour Jones

orifice. The posterior incision is forthwith sewn up, a couple of mattress sutures inserted first to aid in getting good apposition of the skin.

A short length of the ribbon gauze is then withdrawn through the meatus and discarded. The gauze remaining is threaded through a piece of rubber tubing two-thirds inch in length which is pushed through the external canal aperture into the mastoid cavity. I have found it advisable to trim off the sharp edge of the tube and round it, otherwise it will cause a granulation to form on the facial ridge where it impinges.

### Post-Operative Care of the Radical Mastoid

The surgeon must perform all dressings himself, and not devolve them to an inexperienced House Surgeon or Sister. By this practice he gains an intimate knowledge of the appropriate toilette for each individual



LINES OF INCISION FOR PERIOSTEAL FLAP.

FIG. 4.

View showing periosteal flap lines of demarcation.

mastoid cavity and can control exuberant granulations by curettement or tighter packing. This personal supervision has enabled me to surmount all obstacles and obtain a finished result in 95 per cent. of the cases.

The packing is removed on the fourth day by the surgeon unless in a very septic case, when it is removed and renewed on the third day, for two more days, after syringing the cavity with one-eightieth carbolic. I do not repack with ribbon gauze after the fourth day, but pour in liquid BIP and re-insert a slightly longer length of the same calibre rubber tubing with its end trimmed. It is directed backwards into the mastoid cavity. This rubber tube acts as a splint and the epithelium rapidly travels around the walls of the cavity and down the new artificial canal. This or another rubber tube should be fashioned and maintained in position for three weeks. Each time it is changed it is dipped in liquid BIP. The mastoid cavity is irrigated with one-eightieth carbolic every fifth day and any exuberant granulations on the facial ridge rubbed

## Reflections on the Radical Mastoid Operation

away with the instrument depicted in Fig. 5. On the twelfth day treatment with BIP is ended, and from then onwards the cavity is packed with acriflavine gauze (one-thousandth in distilled water). For this a piece of one-inch ribbon gauze about eight inches in length is taken, and the inner part of the cavity tightly packed, especially between the facial ridge and the roof of the mastoid cavity.

I have found that acriflavine solution has the power of suppressing granulation tissue; it must never be used as a first dressing, otherwise the bone may evince no sign of becoming covered with granulations for a considerable period, but it is exceedingly useful for reducing granulations to obtain an even surface for the growing squamous epithelium to cover.\*

The rationale of the after-care is to first stimulate the granulations to grow from the cut bony surface and then repress them.

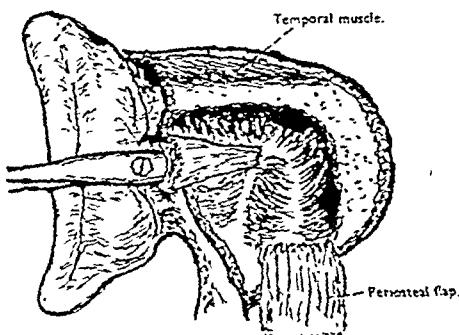


FIG. 5.

View showing mastoid operation completed, artery forceps threaded from behind down the periosteal-cutaneous meatal tube to facilitate trimming it much thinner.

A very rapid improvement in the condition of the mastoid and diminution of the discharge is noted when the acriflavine dressing is initiated. When the radical cavity seems finally epithelialized, there may remain a persistent purulent secretion from it. This is usually derived from carious bone around the external horizontal semicircular canal and aditus ad antrum, and also from the eustachian orifice when it has not been obliterated.

\* Incidentally, I would advise against the use of acriflavine as a primary dressing for cortical mastoid operation wounds. Although it appears to cure the discharge rapidly, yet it will leave a dead space in the bony cavity and occasionally produce a permanent fistula in the skin wound through the rapid invasion of surface epithelium. I recollect one enthusiastic House Surgeon of mine had three of these unpleasant sequelae when I returned from my holidays.

In the after-care of the cortical mastoid operation I have found the most satisfactory method is to use 1 in. ribbon gauze soaked in liquid BIP, as a daily dressing for ten days after the operation. Then syringe out all BIP and substitute 1 in. ribbon gauze soaked in warm eusol.

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The secretion defies all powders, sulphonamides, boric, and iodine, etc., but fortunately we have a sovereign remedy for this condition in the use of eight per cent. silver nitrate in aqueous solution (grs. xl to oz. 1) applied on a pledget of cotton wool. I am convinced that the bone in this "critical area" is the seat of a Buccal Spirochaetal infection, and silver nitrate solution has a deep penetrative action and kills it. Two or three applications may be necessary at intervals of three weeks. A smart reaction of clear watery discharge ensues, and then the cavity dries up completely. After each application of silver nitrate, boric acid powder should be blown into the cavity on the second day after the application.

This treatment of a persistent discharge in the mastoid cavity is the offspring of a method I have been using for years for chronic suppurative

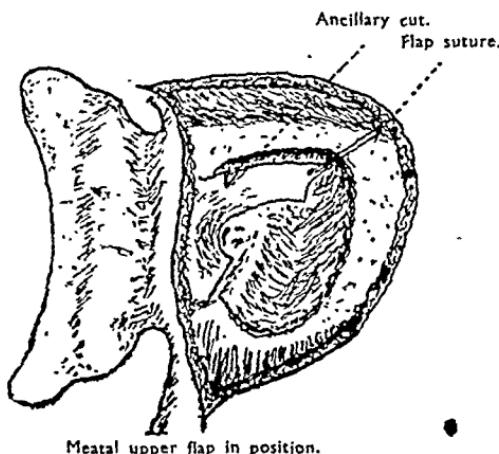


FIG. 6.

View showing upper flap turned upwards and tethered to fascia over the temporal muscle.

otitis media uncomplicated by cholesteatoma. It is especially to be recommended for cases with large perforations in the drumhead, and for cases of muco-purulent otorrhœa, the origin of which appears to be the eustachian tube mucous lining.

I have used it with success when there exists a small central perforation in the drum with otorrhœa.

This method of treatment by the use of 8 per cent. silver nitrate, I discovered originally, when faced in my early days as a practising Aural Surgeon with an elderly patient whose middle ear had continued to discharge profusely in spite of all recognized treatment. It occurred to me that if I was able to apply a sufficiently strong solution of silver nitrate to the eustachian tube, I should obtain closure of the tube and elimination of the discharge maintained by the nasopharyngeal organism, which I concluded was causing persistent inflamma-

## Reflections on the Radical Mastoid Operation

I therefore adopted the following procedure. After removing secretion from the external canal and middle ear, a half sheet of newspaper was taken, a small oval opening being cut in the centre of it and the auricle then threaded through it. This paper shield was to protect the face and eyes. About five drops of 8 per cent. aqueous silver nitrate solution were introduced into the meatus with the patient's head tilted over to the other side, the patient sitting in the examination chair ; the tragus was then pressed down on to the meatus, with the forefinger covered with a finger stall, about six times. This drove the nitrate solution down the eustachian tube and into the interstices of the middle ear. For a few days a watery reaction ensued and then the middle ear dried up completely, and when next I saw the patient a week later, to my surprise the ear was completely free from discharge, the middle membranes were normal, and to my chagrin the eustachian tube was widely patent.

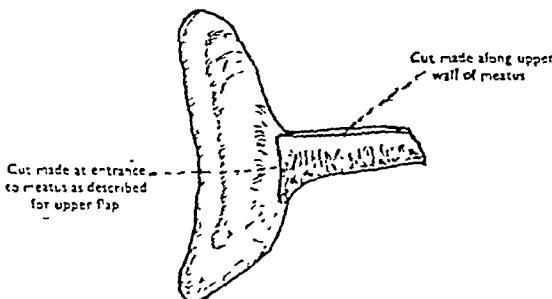


FIG. 7.  
Plan of incision for a lower flap viewed from posterior aspect

To my surprise, however, I discovered that his hearing had vastly improved.

If small granulations are present two or three applications may be necessary at intervals of three weeks. Boric powder is recommended to be blown in after the second day.

Both in chronic suppurative otitis media and in the refractory radical cavity, this method of treatment has enabled me to produce and maintain a dry, satisfactory cavity even though it had persistently discharged for months or years previously. It is sometimes necessary to carry out the treatment more than once, but seldom more than three times. If this proves to be the case the second treatment is used three weeks after the first, and the third treatment three weeks after this.

A recent case in a soldier will show the value of an 8 per cent. solution of silver nitrate in clearing up an intractable discharging radical mastoid.

### *Amnesia*

Radical mastoid 8 years previously.

Discharging profusely for last three years.

## B. Seymour Jones

Has been treated with Boric Acid and Iodine powders, Sulphonamide powders, Penicillin drops.

No improvement.

Referred to me at Towyn for advice.

### Treatment

The cavity was washed out, dried, and the ear filled with 8 per cent. silver nitrate and left for ten minutes. Solution decanted away, but not dried or neutralized. At the end of a week the cavity was almost dry. Second application of 8 per cent. silver nitrate applied—seen in ten days—ear quite dry.

Boric acid and iodine powder advised.

Diploetic mastoids which appear to secrete after operation, and other mastoids which appear to be shaping well and yet cannot attend every week after being discharged from hospital, owing to living some

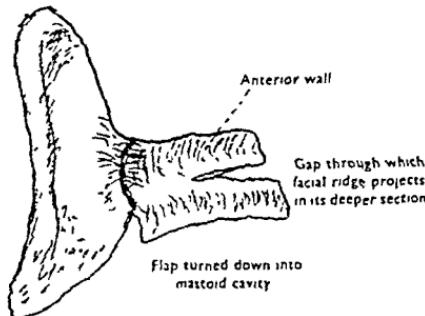


FIG. 8.

Plan for a lower flap with ancillary cut at the deeper part for facial ridge to project.

distance away, seem to respond very well to drops of Zeroform (tribromate of bismuth), 15 grs. to 1 oz. of Spiritus Vini Rect 75 per cent. It is the best drying reagent in my experience and suits most eczema mastoids. Five drops in the ear every two days suffices, later once a week.

### Variations in the Radical Mastoid Operation

The most perplexing cases are those in which stenosis of the external meatal canal occurs. No satisfactory flap can be shaped as the lumen is often reduced to the size of a knitting needle. I have grafted several of these, but a number of failures must be recorded, as the condition is often the result of chronic eczema associated with otitis media chronica. They are a long time healing as there is no source of squamous epithelium to spread from. Zeroform or bismuth gauze is my stand-by, with tight packing if the skin graft fails.

If the bone roofing the attic and antrum appear carious or necrotic,

## Reflections on the Radical Mastoid Operation

or a brain abscess be suspected, I make a lower flap by cutting along the roof of the cutaneo-periosteal sleeve and turning down a flap. There is no need to thin it as the intact flap helps to fill up the mastoid cavity. Another ancillary incision must be made as shown in Fig. 6 ; this is cut from within outwards, to allow the facial ridge to present through it and avoid any narrowing at the inner end ; as the flap has a good blood-supply it always survives, but the lower flap variant never yields such a good final cosmetic result as the upper flap and has the additional disadvantage that the packing of the upper section of the mastoid cavity has to be more circumspectly done. Incidentally the periosteal flap is not applicable in these cases.

A certain proportion of radical mastoids are met with, in which the greater part of the mastoid cells are digested away and replaced by a septic cholesteatoma.

It is my practice to employ an upper meatal flap in these cases and dispense with the periosteal flap. No skin grafting is necessary : when once the Haversian canals of the bone have been invaded by pavement epithelium, they will continue their evil course of exfoliation and must not be covered in by muscle graft or other soft tissue. These cases always require supervision at four months' intervals and removal of accumulated debris.

### After-Treatment of Mastoids

As soon as the mastoid cavity is dry a trace of Boric and Resublimated iodine 0·75 per cent. is enjoined to be blown in once a fortnight to prevent the growth of *Aspergillus flavum* and *nigrum* which left unchecked will inevitably lead to a dampness in the cavity and desquamation of the epithelium and fresh granulations.

There are however individuals who are allergic to Boric Acid and Iodine, so Zeroform (Tribromate of Bismuth) may be substituted for the former powders.

It has been my practice to see every case of radical mastoid at intervals of four months, to remove any accumulation of dead exfoliated cells and debris.

No single case can be assured of complete freedom from otorrhœa at some future date. I have seen cases behave exemplarily for seven years and then in one short year present themselves with the cavity filled with a septic cholesteatoma.

I should like to express my most grateful thanks to Mr. Stirk Adams for so kindly revising the manuscript.

# SOME OBSERVATIONS ON THE ETIOLOGY OF FOREIGN BODIES IN THE CESOPHAGUS

By PHILIP READING (Birmingham)

FROM a perusal of the literature, it seems that any object capable of being swallowed has managed, at some time or other, to become impacted in the oesophagus. A very full account of the treatment of oesophageal foreign bodies and their complications has recently appeared in the pages of the *Journal of Laryngology and Otology* (Flett, 1945). It would be of interest to enquire how foreign bodies come to be swallowed.

During the last seven years, I have carried out 114 oesophagoscopies for suspected foreign bodies and have found and removed them in 84 cases. No complications or deaths occurred in this series.

			Nature of foreign bodies		
			Coins .. .. ..	29	
Children below the age of thirteen	..	33	Meat bone .. .. ..	1	
			Toy soldier .. .. ..	1	
			Curtain ring .. .. ..	1	
			Jack stone .. .. ..	1	

			Nature of foreign bodies		
			Coin .. .. ..	1	
Patients over the age of thirteen	..	51	Meat bones .. .. ..	40	
			Meat bolus .. .. ..	5	
			Safety pin .. .. ..	1	
			Needle .. .. ..	1	
			Beer bottle cap .. .. ..	1	
			Brooch .. .. ..	1	
			Denture .. .. ..	1	

Of the patients in this older age group, all had upper dentures with the exception of six, who had their own teeth. These six swallowed respectively a brooch, a safety pin, a needle, a beer bottle cap, a bolus of meat and a bone.

The causes of swallowing a foreign body can be found in one of the following three categories.

1. *The patient knows the foreign body is present in his mouth, and swallows it by accident.*

Safety pins, coins and toys find their way into the baby's mouth, because the baby's first reaction with any object is to find the nature of it by sucking it. Older children hold coins etc., in their mouths for the pleasure of palpating a thing with the lips and the tongue. They

## Foreign Bodies in the Oesophagus

also put them in their mouths for the purpose of concealing them from their friends, and in the ensuing struggle for the coin, the child swallows involuntarily and the coin slips down. A girl of fifteen, "larking with her friends" swallowed a brooch, which they were trying to prise out of her mouth. An elderly hemiplegic, receiving his old age pension, tried the money by biting it, and while he was testing a half-crown in this manner, he fell asleep, and, when he awoke, the coin had been swallowed and lay in the oesophagus at the aortic crossing. Another instance is of a man, engaged in showing his friends at a public house a new method of removing the metal caps from beer bottles. He inserted his upper incisors under the fringe of the cap and levered the bottle down. Unfortunately, the cap slid down with the beer, and proved to be a very difficult object to remove from the upper oesophagus.

### 2. *The patient deliberately swallows the foreign body.*

The "difficult child" swallows things to draw attention to herself and becomes the centre of interest to her parents. I recently removed a halfpenny from the oesophagus of a child of five, who, the year before, had had a safety pin removed at another hospital, and, who, according to the mother, was very jealous of her younger sister.

Things are also deliberately swallowed to gain some advantage. A tramp was admitted with an open safety pin in the lower end of the oesophagus. He later told me that he had played the same trick before in other parts of the country, and apparently thought that the pain and discomfort were worth suffering to obtain a few days rest in hospital. A trick of prisoners is to blunt the end of the needles, used in sewing mail bags, against a stone, and then to swallow one or more needles. The foreign body passes into the intestines, is quite harmless, and gets the prisoner a few days in the comfort of the prison hospital. One young man who was sent for oesophagoscopy, had not quite mastered the technique; he had swallowed the needle without first blunting it, and it had become impacted across the mouth of the oesophagus. It was removed without incident.

Mental defectives often swallow large numbers of foreign bodies, but, for some reason, they seem rarely to lodge in the oesophagus, but accumulate in the stomach. A point worthy of note is that a mental defective or imbecile, who refuses to swallow his food, may do so because a foreign body is impacted in the oesophagus, and he is prevented by his mental infirmity from drawing the attention of the nurses to it. An imbecile child, completely bedridden, quadriplegic and inarticulate, was brought to the hospital because he had for six weeks refused all nourishment beyond occasional sips of water and milk. His only form of self-expression was to roll his head to-and-fro. Clinical examination revealed no abnormality, but an X-ray showed a toy soldier impacted

# Philip Reading

transversely across the upper end of the oesophagus. Removal of this was followed by immediate resumption of normal feeding.

### 3. *The patient swallows a foreign body, because he does not know that one is in his mouth.*

Negus (1943) divided the act of swallowing into three stages. The first sees the food seized by the lips and teeth and taken into the mouth, in the second the food passes from the level of the palatine folds to the mouth of the oesophagus, and in the third it passes down the oesophagus. Only the first stage and the initiation of the second are under the control of the voluntary will, and, once the bolus has passed the level of the palatine folds, the onward progress of any foreign body present in the bolus depends upon its shape and its presentation.

The functions of the tongue are ". . . not only for purposes of mastication but also for prehension . . . A further function of the tongue in many animals is propulsion of food into the pharynx . . ." (Negus). There is one further function not frequently stressed, and that is that the tongue acts as the sentinel over the passage of food and detects and rejects bony or other particles. Chevalier Jackson teaches the importance of the sensitive laryngeal reflex as "the watch dog of the lungs" in expelling solid, liquid or gaseous contaminants of the inspired air. A guardian is also required for the alimentary tract, though it can tolerate grosser insults than can the lungs.

The tip of the tongue is extremely sensitive; its powers of analysing spatial quality of touch and its tactile discrimination are greater than those of any other part of the body. Starling (1926) states that it can distinguish the blunted points of a pair of calipers as giving two definite stimuli, when they are as close together as 1.1 mm., whereas the pulp of the finger requires them to be separated to double that distance before they can be recognized as two separate points of contact.

The hard palate is also supplied with touch receptors, which, while they are accurate, are not so sensitive as those of the tip of the tongue. During mastication, the tip of the tongue presses the bolus of food against the hard palate, and, rapidly penetrating the broken masses of food, palpates them against the hard palate, in much the same way as the finger and thumb roll an object between them to ascertain its shape and consistency. In this way a bone is quickly detected and ejected. Though one may be conscious of a small bone, like a fish bone, in the mouth, it is not accurately localized till the bolus has passed through this process of "hand-picking" by the tip of the tongue and the front of the hard palate. In the normal propulsion of food from the mouth into the pharynx by the arching up of the tongue against the hard palate, a further opportunity is afforded for a foreign body to be detected.

One is struck by the frequency with which upper dentures are found

## Foreign Bodies in the Oesophagus

in the mouths of those who have swallowed a bone (39 patients in my series against one who had all his own teeth). The inference is that the hard palate, or its more important part, the anterior portion, is covered with a dental plate and the accuracy of the tongue seems to be thereby reduced. The bolus of food is now capable of smuggling a bone past the tip of the tongue and down into the oesophagus. People who have the misfortune to be compelled to wear an upper denture should be warned of their special liability to oesophageal foreign bodies and should take great care in ascertaining that their food is free from splinters of bone.

"Though seen of none save him whose strenuous tongue  
Can burst Joy's grape against his palate fine." (KEATS)

Chevalier Jackson (1936) states that, in his two large series of foreign bodies removed endoscopically, 612 and 2,500 respectively, he considered that artificial dentures, by preventing palatal detection of the presence of a bone in food, contributed in forty-four cases. The much higher incidence of a dental plate as an etiological factor in my very much smaller series, can be explained by the greater conservatism of American dentists and consequently, the greater rarity of dental plates in the mouths of the population.

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## CLINICAL RECORDS

### A CASE OF MEDIASTINITIS

By R. B. LUMSDEN (Edinburgh) and A. LOGAN (Newcastle-on-Tyne)

WHILE drinking tea on *November 14th, 1944*, Sapper J. H., aged 42, felt in his throat something which he regarded as a piece of wood. After this, he felt discomfort in the left side of the throat about the level of the thyroid cartilage, on swallowing or lying down, but he was still able to swallow solids and liquids. He reported sick two days later and was admitted to a Middle East general hospital.

On examination, some injection of the left pharyngo-epiglottic fold was noted and there was an excess of mucus present. X-rays revealed no opaque foreign body, but screen examination showed some delay in the passage of barium, with no localized deformity. Four days after the accident he was entirely free of symptoms and indirect laryngoscopy revealed normal findings.

In view of the delay in the passage of barium, *oesophagoscopy* was considered advisable, to exclude neoplasm. This was carried out, under local anaesthesia, on *November 22nd*—eight days after the accident and four days after all symptoms had disappeared (R.B.L.). On the right side of the posterior wall in the lower post-cricoid region, a narrow horizontal slough was found. There was no evidence of a foreign body. Sterile water only was allowed and dry sulphathiazole powder was swallowed at four-hourly intervals.

Twenty-four hours later his temperature was  $100^{\circ}$ , pulse-rate 112 and respirations 22: there was some fullness of the supraclavicular region on both sides and an area of surgical emphysema on the right side. Heart and lungs were normal. Water by mouth was stopped and continuous intravenous glucose saline administration was commenced, with the addition of sodium sulphathiazole (6 grams in 24 hours). Intramuscular penicillin was started (15,000 units 3-hourly).

At the end of a further 24 hours the patient's condition was unchanged. X-ray examination showed:—(1) Enlargement of the upper mediastinal shadow on the right side, with a well-defined limiting margin extending from the root of the lung upwards into the neck. (2) Surgical emphysema in the lower neck, especially on the right side (Fig. 1). On this day (*November 24th*) *mediastinotomy* was carried out (R.B.L.) under pentothal and cyclopropane anaesthesia (Lt.-Col. Brennan), through an incision low down on the anterior border of the right sternomastoid muscle. The omo-hyoid was retracted downwards and medially, the pre-tracheal fascia was divided and 2-3 ounces of offensive purulent fluid was evacuated. No foreign body was found. A rubber drain was inserted and the wound partly closed. On *culture* of the pus there was a moderate growth of haemolytic streptococcus and a slight growth of *Staphylococcus aureus*. Both were *penicillin-sensitive* (factor 1·0) but *sulphathiazole-resistant*.



FIG. 1.  
Showing enlargement of the upper mediastinal shadow.

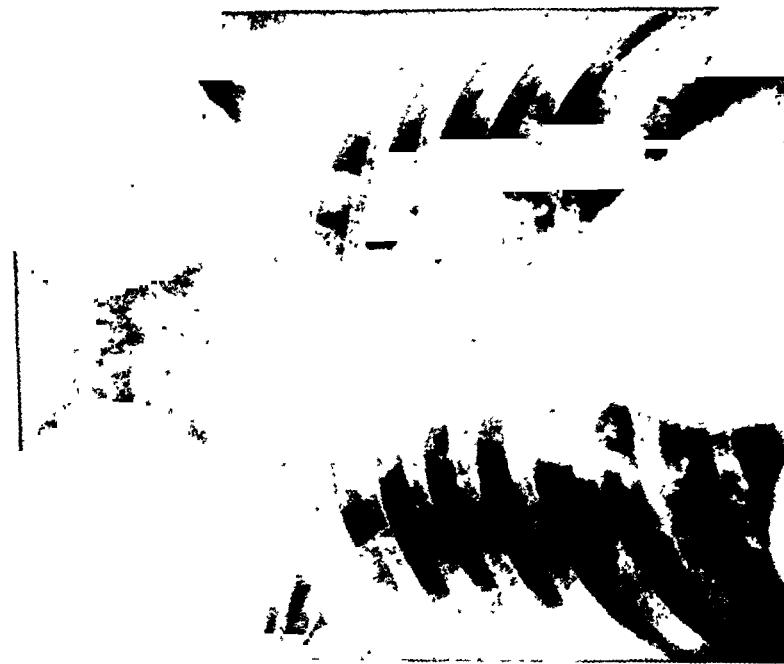


FIG. 2.  
Showing decrease of mediastinal shadow.

FIG. 3  
Showing lipiodol at the level of the 6th dorsal vertebra, in the mid-line

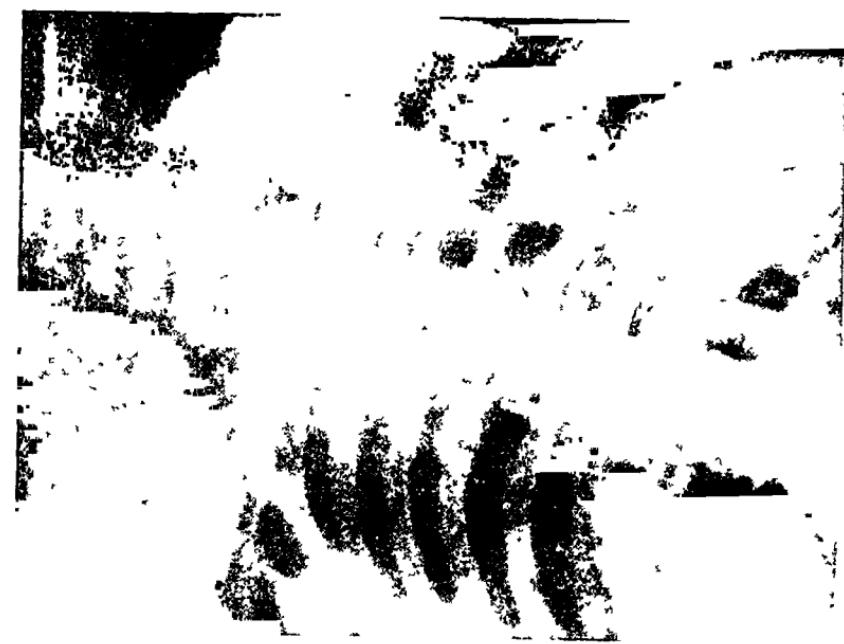


FIG. 4  
Showing lipiodol in the posterior mediastinum

Showings hold-up of bottom in the upper 11' samples.

Pla. 5.  
Pla. 6.



Showings hold-up of bottom in the middle samples.

Pla. 5.  
Pla. 6.



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## Clinical Records

Temperature and pulse remained elevated for several days, but the patient's general condition improved. There was profuse offensive discharge from the neck wound. Three days after operation, X-rays showed no appreciable change; sodium sulphathiazole was stopped (Total during first course—24 grams). The white cell count was 10,400 with 72% polymorphs, haemoglobin was 95%. A swab taken from the wound gave a moderate growth of *Staphylococcus aureus* which was now penicillin-resistant; and a slight growth of a non-haemolytic streptococcus, slightly penicillin-sensitive (factor 0·4). A few sips of boiled milk appeared in the neck wound; therefore, on November 29th, a gastrostomy was performed under local anaesthesia (Lt.-Col. Marnham), after which the intravenous drip was discontinued. Further X-ray examination at this stage showed no appreciable change, but on December 5th (eleven days after drainage operation) the mediastinal shadow had decreased appreciably and the surgical emphysema in the neck had resolved (Fig. 2).

Penicillin was stopped (Total during first course—1,315,000 units). A swab from the wound at this stage gave a heavy growth of *Staphylococcus aureus*—penicillin-resistant, a moderate growth of non-haemolytic streptococcus—penicillin-sensitive; and a slight growth of diphtheroids—penicillin-sensitive.

Improvement was maintained till December 10th, when temperature and pulse-rate again rose and he complained of pain in the right upper chest on coughing. Physical examination showed some indefinite signs in the right chest, with slightly impaired movement and diminished air-entry. The white cell count was 22,000 with 89% polymorphs. X-ray showed no appreciable change in the mediastinal shadow, but there was some loss of translucency in the right upper lung field, adjacent to the mediastinum. Sulphathiazole by gastrostomy and intramuscular penicillin were resumed (Totals during second courses: sulphathiazole—70 grams, penicillin—890,000 units).

On the same evening he coughed up 5 ounces of thick pus and 10 ounces of offensive discharge came away from the neck wound while coughing. Next day there was considerable improvement and thereafter the neck wound gradually cleared up; but during the following four weeks he continued to cough up a variable amount of pus which was sometimes blood-stained. On four occasions during this period, diminution of sputum to 1-2 ounces in 24 hours was associated with a rise of temperature which dropped when the quantity of sputum again rose to about 10 ounces. There was little doubt that a bronchial fistula was present. Culture of sputum gave a moderate growth of *Staphylococcus aureus* which was penicillin- and sulphathiazole-resistant; and a slight growth of a non-haemolytic streptococcus which was penicillin-sensitive (factor 1·0). Examination for tubercle bacilli was negative on eight occasions. Gastric contents were acid and contained no pus cells.

On December 12th 10 c.c. of lipiodol were instilled into the neck fistula and subsequent X-rays showed that most of this was in the mid-line at the level of the 6th dorsal vertebra, while a small amount reached the upper zone of the right lung (Fig. 3). An oblique view confirmed that this was in the line of the oesophagus in the posterior mediastinum (Fig. 4). On December 23rd, having ascertained that the lipiodol had practically cleared, he was given some barium paste (containing sulphathiazole) by mouth, which was seen to be held up above the level of the aortic arch (Fig. 5). Twenty-four hours later

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it was found to be at the level of the 6th-7th dorsal vertebrae—where the lipiodol *via* the neck was previously held (Fig. 6).

In consultation on December 30th, it was agreed that the necessity for further operation seemed probable and he was transferred to a Chest Unit under the care of A.L.

At this time the patient's general condition was fairly good. There was no abnormal glandular enlargement and no finger clubbing. Rib movements and lung expansion were equal. There were some ronchi over both sides of the chest, but especially over the right upper lobe. Liver and spleen were not palpable. He was coughing up 15 ounces of foul-smelling pus daily; but from this time onwards he made slow but uninterrupted progress.

At *bronchoscopy* under local anaesthesia (A.L.), on January 12th, 1945, some muco-pus was seen in the eparterial bronchus and there was some oedema of its ostium but no other abnormality. Sputum culture gave a growth of non-haemolytic streptococcus and diphtheroids. A *bronchogram* (A.L.) showed no evidence of escape of lipiodol from the bronchi and the bronchial outlines were not grossly abnormal. A *barium swallow* on April 13th showed a stricture of the oesophagus just below the cricoid cartilage, with a partial hold-up of barium above it. There was an irregularity in the shadow at the level of the 6th dorsal vertebra. *Oesophagoscopy* under local anaesthesia (A.L.) showed a stricture two inches below the upper end of the oesophagus.

The patient was very well when discharged from hospital on April 20th, for evacuation to the United Kingdom; but it was considered most probable that subsequent oesophageal bouginage would be required.

Our thanks are due to Major W. S. Shearer, Radiologist, for his helpful co-operation in dealing with this case.

## RHINOLITHS:

### THE REPORT OF AN ANTRAL AND THREE NASAL STONES

By A. T. CUNNINGHAM (London), O. C. LORD, C. H. MANLEY,  
and C. J. POLSON (Leeds)

A COMPREHENSIVE review on rhinoliths was published by Polson in 1943, but their infrequency merits a brief record of four new specimens, one of which is an antral rhinolith, the eighth to be described.

Only five rhinoliths have been described since 1942, namely, those by Samuel (1943, two cases), Stauffer (1943), Munson (1944), and by Lord (1944; the seventh antral rhinolith). Nine other cases, which escaped notice in 1943, include those of Johnson (1891), Krieg (1901), Arslan (1921), Suné Medan (1923, 3 cases), Vulowitsch (1926), de Croote (1927), and Green (1939).\* It may be mentioned that the rhinolith, ascribed to Chiari (1895) by Hérisset (1904), was present in a nasal fossa closed by choanal atresia, a unique coincidence, although two instances of foreign bodies in atresic nasal fossae, namely, a cherry stone, and a laminaria bougie, have also been recorded (Stewart 1931; Bleyl, 1902).

#### CASE I. RHINOLITH FROM A LEFT MAXILLARY ANTRUM. (A.T.C. and C.J.P.)

This was removed from a woman aged 46, who had had a left nasal discharge for about 30 years. It began following the extraction of a tooth from the left upper jaw. The antrum, as shown by proof puncture and lavage, contained pus; a skiagram also demonstrated the presence of a foreign body, either the root of a tooth or a piece of bone. A fistula, which only admitted a probe, was present between the alveolus and the antrum. This was repaired by plastic methods and the rhinolith was extracted by the Caldwell-Luc operation.

The specimen (Fig. 1) consisted of a nucleus and two calcareous fragments, which formed part of its covering. The nucleus,  $14 \times 6 \times 6$  mm., had a somewhat conical shape, the base being irregular. It was composed of grey flint-like material, of the density of enamel; it could be cut with a saw. Scratching its surface with a pen-knife resulted only in the removal of flakes of the calcareous concretion; the nucleus itself was thus burnished, but otherwise unaltered. It resembled, superficially, the root of a tooth, but no pulp cavity was demonstrable, and its uniform hardness, and compact texture suggested that it was a fragment of bone.

The incrustation contained : water 1·7%; organic matter 11·6% and mineral matter 86·7%. Complete analysis was impracticable, but there was a high proportion of calcium phosphate, along with some calcium carbonate, in the mineral matter. (C.H.M.)

#### CASE II. RHINOLITH FROM A LEFT NASAL FOSSA. (A.T.C. and C.J.P.)

This large stone (Fig. 1), was removed from a man aged approximately 55, who, for two years, had had obstruction of the left nostril; he had had a

\* Vulowitsch (1926) also described a large rhinolith, with a nucleus of flint, in an atresic nasal fossa; right bony choanal atresia.

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nasal discharge for about 18 months. This was purulent, and a white "membrane", distinctly hard to the probe, was seen in this nostril. When the pus was swabbed away, a rhinolith was apparent. Its anterior limit coincided approximately with the anterior end of the inferior turbinate body; posteriorly it projected from  $\frac{1}{8}$  in. to  $\frac{1}{4}$  in. beyond the choana. The radiological appearances are seen in Figs. 2 and 3. The stone had to be removed piecemeal. When dry, its fragments weighed 4 drachms 3 grains (approximately 15 gm.)

The specimen had a dirty grey exterior, but it was generally of cream colour, and was composed of granular and somewhat friable material.

Two principal fragments were accompanied by twenty others of from about 5 to 15 mm. in their maximum diameters, and about 35 smaller fragments.

The principal fragment, the posterior part of the rhinolith, was irregular,  $25 \times 23 \times 15$  mm., but formed a rough cast of the interior of the nose. The base of this piece was pared away and this displayed a small oval pebble,  $13 \times 6 \times 4$  mm., of slate colour. The second largest fragment measured  $18 \times 15 \times$  about 5 mm., and the two large fragments, when joined, were an approximate reproduction of the original stone.

The incrustation contained: water 3.9%; organic matter 6.6%; magnesium carbonate 5.3%; calcium carbonate 8.4%; and calcium phosphate 75.8%; total 100.0% (C.H.M.).

## CASE III. RHINOLITH FROM A LEFT NASAL FOSSA. (A.T.C. and C.J.P.)

This was removed from an adult male, who had had nasal obstruction on the left side for 2 or 3 months; he had had epistaxis as a child.

The rhinolith weighed 1.31 gm., and was somewhat pyramidal in shape. Its outer surface was dark brown, and it had a rock-like consistence. It was opened by saw cut, which demonstrated a soft, compact, laminated nucleus, apparently fibrous, composed of small fragments of paper, on one of which some printing was still legible (Fig. 1); the paper was thicker than ordinary newspaper, but not quite as thick as cardboard. It was completely surrounded by a hard calcareous shell, 1 mm. thick, but there was insufficient for chemical analysis.

## CASE IV. RHINOLITH FROM A LEFT NASAL FOSSA. (O.C.L. and C.J.P.)

This was removed from a young woman of 23, who had had nasal obstruction for as long as she could remember. There was no history of the insertion of a foreign body.

The detection of the stone presented no great difficulty; it was apparent by anterior and posterior rhinoscopy. The anterior, pointed end was within 1 in. of the anterior naris, and its posterior end reached the left choana. Some nasal polypi were also present. Probe examination readily detected a stony hard body in the left nasal fossa; since it was an obvious rhinolith, radiological examination was not undertaken. Her doctor, Dr. E. Cretney, reported a year later, that complete cure had followed removal of the stone.

The stone was removed piecemeal, and some 27 fragments were collected, ranging from pinhead size upwards to one of  $30 \times 16 \times 2$  to 5 mm. The fragments weighed 9.3 gm., and the average size of about 25 of them was  $8 \times 5 \times 1$  to 2 mm. The largest had a small hole, 1 mm. in diameter, at a

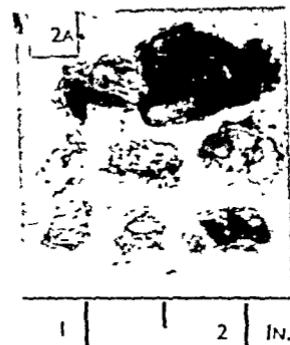
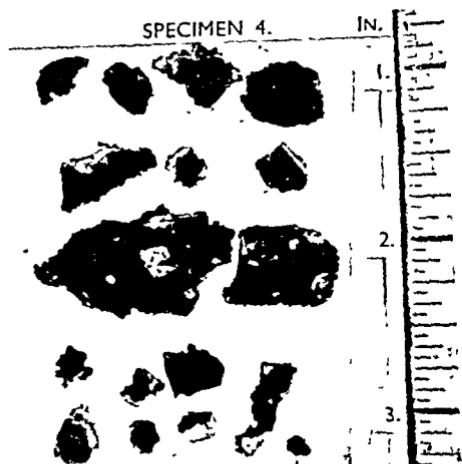
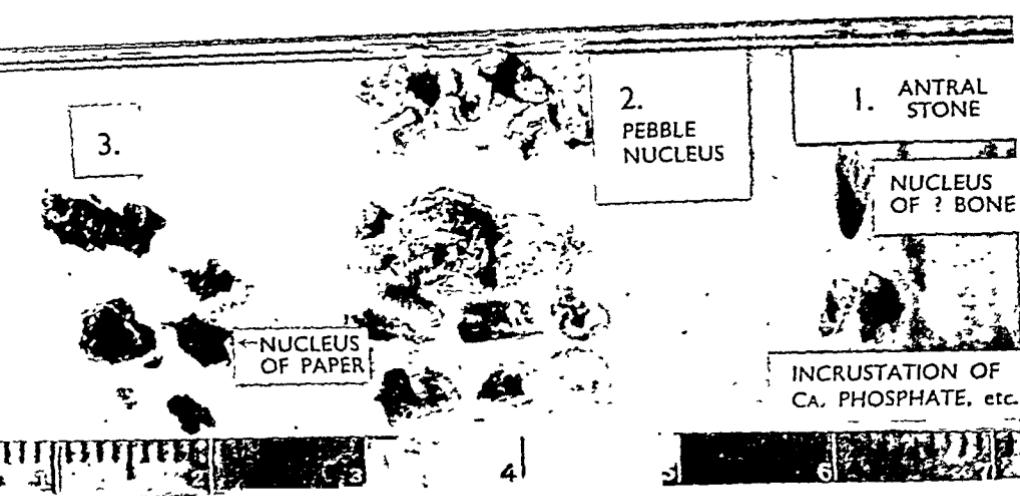


FIG. 1.

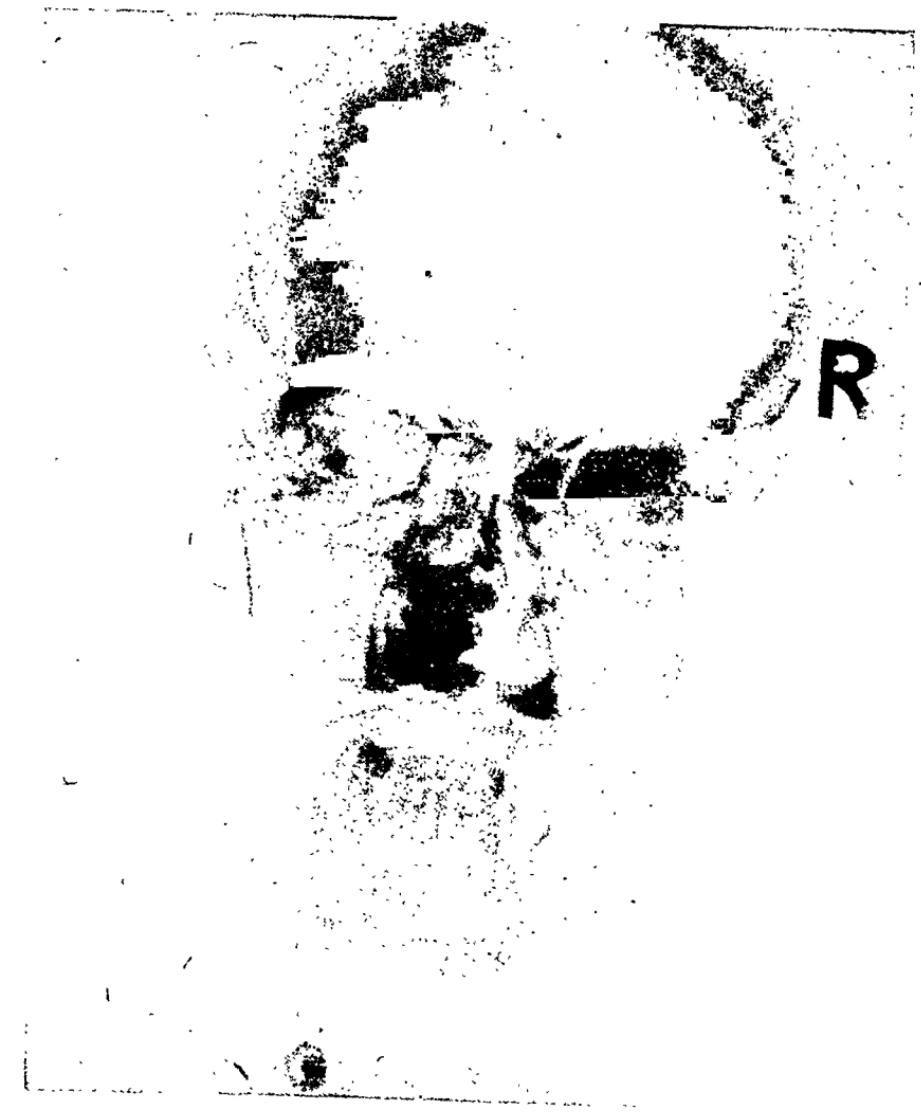


FIG. 2.

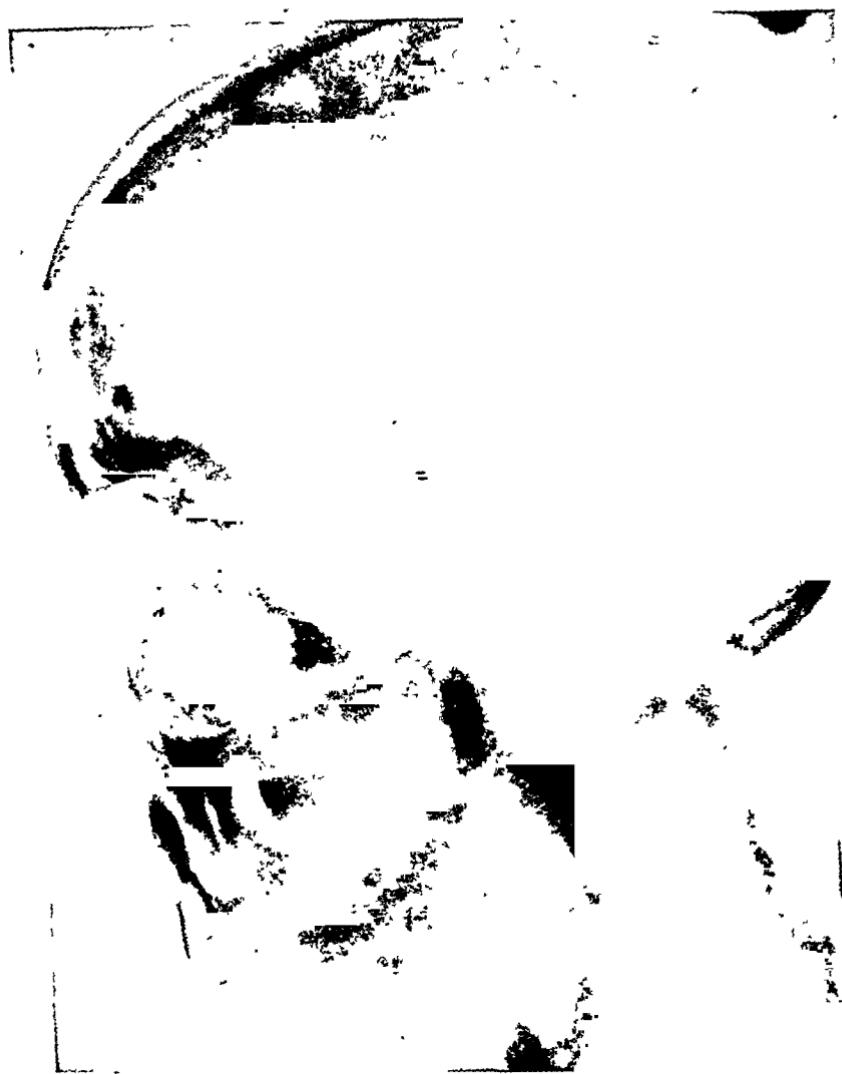


FIG. 3.



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point 1 cm. behind its anterior end. It was impossible accurately to reconstruct the stone, but the two principal portions were representative of its original form (Fig. 1). It had measured approximately 45 mm. antero-posteriorly, and up to 16 mm. in its vertical axis; it was thickest posteriorly, where it measured only 5 mm. across. The stone was an imperfect cast of the left inferior meatus; there had been many small projections from the surface of the stone. Above, there was a shallow furrow, in which the lower border of the inferior turbinate body had probably lodged. The outer surface of these fragments varied from dark fawn to almost black colour, but this was only a superficial coating of altered blood; the substance of the stone was of yellowish colour. Owing to the fact that at no point did it exceed 5 mm. in thickness, it was improbable that the specimen contained a foreign body, and, it was decided not to make an exhaustive search for one, since the specimen was required for the museum.

The incrustation contained: water 5.1%; organic matter 16.5%; calcium carbonate 3.6%, and calcium phosphate 74.8%; total 100.0% (C.H.M.)

### COMMENTARY

These stones present no unusual features, and their chemical analyses confirmed those already published; it was demonstrated that their principal component was calcium phosphate. It was also shown that no real difference is likely to exist between the composition of the incrustation of nasal and antral rhinoliths. The latter, in view of the anatomy of the antrum, are likely to be rare, and Case I is only the eighth to be described, and the third to be submitted to chemical analysis. As in this case, the likely route of entry of the foreign body is *via* the floor of the antrum, following a dental operation, when the nucleus will be either the root of a tooth or a piece of bone. Drainage apparatus has also escaped into the antrum by this route. The stone in Case II belongs to the massive group, i.e. those of 30 to 55 mm. long, and of over 10 gm. in weight; pebbles have occasionally formed the nucleus of a rhinolith. The third stone recalls Seeligmann's specimen (1892), in which printing was still legible on the nucleus of paper. The interest of the fourth stone lies, not only in its large size but, more especially, in the probable absence of a foreign body nucleus. This is suggested with hesitation because few genuine examples, notably Moure's case (1894), have been described. The present stone had to be removed piecemeal and, therefore, its nucleus may have escaped detection, but it is unlikely that any existed in the specimen examined.

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## SOCIETIES' PROCEEDINGS

### ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLOGY

March 2nd, 1945

*President*—L. GRAHAM BROWN, F.R.C.S.

#### Lesions of the Facial Nerve due to War Injuries and their Repair

By Major FRANK D. LATHROP (Boston, Mass.)

TRAUMATIC lesions of the facial nerve in its course through the temporal bone, neck and face constitute a small proportion of all wounds resulting from modern warfare and are of minor importance as a casualty figure. However, such injuries are of major concern to the recipient. The soldier afflicted with a complete peripheral facial paralysis often regards his disability as catastrophic and the constant facial asymmetry and the hideous distortion occurring on emotional stimulation are frequently of such a degree as to cause the individual to shun his fellow-men. Alterations in the sociologic, psychologic and economic status of such patients are not uncommon and justify every effort being made to rehabilitate the casualty without delay.

During the past seven months, 40 cases of facial nerve paralysis of the peripheral type, secondary to wounds received in the present war, have been encountered. The facial nerve has been explored in 27 of these patients in order to determine the nature of the injury to the nerve and to effect a repair whenever possible. The lesions presented in this series emphasize the complexity of the destructive processes wrought by both high and low velocity missiles with respect to the facial nerve and demonstrate that the anatomical restoration of the continuity of the facial nerve may be possible in the majority of cases.

Trauma to the facial nerve incurred as a result of battle wounds varies with the type of wounding agent and the location and extent of the wound. Fractures of the facial bones, mastoid process or skull are almost always present in such battle casualties and concurrent paralysis of the 2nd, 5th, 6th, 8th, 9th, 10th, 11th, and 12th cranial nerves are not uncommon.

The location and extent of the wound are of significance in evaluating the injury sustained by the nerve. An extensive wound may present multiple areas of damage, the presence or absence of which can be ascertained only by careful search of the facial nerve in the path of the wound. In one case in this series the facial nerve presented a large neuroma at the level of the stylo-mastoid foramen, partial destruction of the cervical trunk and avulsion of the pes anserinus and adjoining branches. Gutter wounds of the temporal bone superior to the external auditory canal and those grazing the mastoid process produce a concussional type of palsy. In the present series these recovered spontaneously. Wounds involving the mastoid process at the level of the

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external auditory canal or below produce facial palsy as a result of contusion or destruction of a portion of the nerve. Penetrating or perforating wounds in which the point of entrance or exit is situated just anterior to the lobule of the ear offer a poor prognosis for reconstruction of the continuity of the facial nerve as the pes anserinus may be destroyed. Branches of the facial nerve, in its distribution to the facial muscles, are, on occasion, contused or severed by deep lacerations and result in partial paralysis of the face.

The nature of the agent producing the paralysis is of importance. While it has been impossible to obtain this information in each case due to the casualty's lack of definite knowledge regarding this point, sufficient data have been accumulated to permit an evaluation of the effect of blast and high and low velocity missiles upon the facial nerve.

Facial paralysis secondary to the blast of nearby explosives apparently are the result of an intraneuronal pathologic change produced by the pressure waves associated with such explosions, as in no case was a fracture of the temporal bone discernible by roentgenologic examination and spontaneous recovery occurred. Deafness and rupture of the tympanic membrane, as further evidence of the blast effect, was noted in each case.

High and low velocity missiles, on the other hand, are almost always associated with fractures of the temporal, mandibular or maxillary bones and cause paralysis as a result of concussion, compression, contusion or interruption of the nerve. There has been little difference noted between the amount of destruction caused by either of these two projectiles. The former produce either wounds of the perforating type with small entrance and exit points and extensive fracturing of the mastoid process, or large gutter wounds of the soft tissue and relatively slight disruption of the mastoid. The flat trajectory characterizing such missiles and causing roughly horizontally lying wounds tends to involve the vertical position of the facial nerve in the region of the stylomastoid foramen and the cervical trunk or its facial distribution. Injury to the facial nerve by low velocity missiles is almost always associated with extensive fracturing of the mastoid process. Such wounds are of the penetrating type and present wide destruction of the nerve. On occasion minute fragments may either enter the external auditory canal or pass between the stylomastoid foramen and the mastoid tip to either section or contuse the facial nerve.

The most significant feature of those wounds which resulted in interruption of the facial nerve is the magnitude of the loss sustained by the nerve. Exploration, on occasion, demonstrated the facial nerve to be either missing or so badly traumatized as to require excision from the region of the geniculate ganglion to within a few millimetres of the pes anserinus, a distance of approximately 65 mm. Losses involving a portion of both the mastoid and cervical segments are common. Infrequent, but offering an extremely poor prognosis for repair of the nerve, are those wounds which destroy the pes anserinus as well as its immediate branches. Avulsion of the facial nerve in its petrosal course is rare but did occur in one case. Interruptions of lesser magnitude do occur and are located usually in the cervical trunk or the distribution in the face.

Civilian experience would lead one to believe that radiography and electrical reactions and tests for taste and hearing would reveal if the nerve had been

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severed and also the approximate site of injury. However, in this series such examinations have been of relatively little practical value.

Taste testing has been unreliable in the majority of patients and has in all probability been due to the severe concussion which the nerve has sustained. Tests for the presence or absence of lacrimation have been more reliable. X-ray studies have been difficult to evaluate due either to failure of displacement of the fragments in the presence of an existing fracture or to an inability to determine which fracture is producing the injury to the facial nerve. Faradic stimulation, however, has been of some value either in evaluating those paralyses secondary to concussion or in making the decision whether or not to explore a large wound in the vicinity of the parotid gland. Galvanic response has been elicited in every case tested.

The treatment of facial paralysis due to injury of the facial nerve at any point in its pathway through the temporal bone, neck or face incident to war wounds is surgical. That such surgery is justly the domain of the otologic surgeon should be without question. An exact knowledge of the anatomy of the facial nerve and the pathologic processes within the middle or inner ear with which such lesions are frequently associated are prerequisites for surgical intervention.

For restoration of function of the facial nerve operations such as decompression, end-to-end suture, nerve grafting or anastomosis of the distal stump of the facial nerve to the central end of an adjacent cranial nerve are successful in the majority of cases. Decompression is readily achieved following the accomplishment of either a simple or radical mastoidectomy as may be indicated by the pathologic process present. Exposure of the facial nerve within the fallopian canal is obtained by removing the postero-lateral bony canal wall on either side of the lesion until normal nerve tissue is observed and should be followed by slitting the sheath of the nerve. Compression by displaced fragments of bone, foreign bodies or edema may be relieved in this manner.

Division of the facial nerve requires that the divided ends be freshened and the continuity restored whenever possible by end-to-end suturing or nerve grafting. When there has been but little loss of substance the junction may be obtained by mobilizing the distal segment in the neck and parotid gland and by exerting traction to gain about 6 mm. Greater losses can be overcome by re-routing the nerve should the pathologic process present permit a radical mastoidectomy. Gaps up to 23 mm. may be closed in this way.

Re-routing the facial nerve is a simple surgical procedure. A radical mastoidectomy is performed and the nerve uncovered sufficiently to permit lifting it out of the fallopian canal from the geniculate ganglion to the stylo-mastoid foramen. The cervical trunk of the facial nerve is liberated from the surrounding soft tissues and, if necessary, the dissection carried forward into the cheek so as to obtain greater mobilization of this portion of the nerve. Removal of the vaginal process of the temporal bone allows the nerve to be re-directed so that it courses from the geniculate ganglion vertically across the middle ear into the neck and permits end-to-end suture without tension (Fig. 1).

If approximation of the divided ends cannot be accomplished by either of these methods, then recourse must be taken to nerve grafting in order to

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bridge the defect. For this purpose it is convenient to utilize the anterior femoral cutaneous nerve as the donor. The proximal and distal stumps of the facial nerve are carefully shaved until healthy nerve tissue is apparent and measures have been taken to insure a bloodless operative field. A segment of the proper length is obtained from the donor nerve and inserted into the defect of the facial nerve so as to allow coaptation of the ends of the graft with those of the facial nerve. A nerve graft lying within the fallopian canal does not require suturing. However, in those cases in which the opposing ends lie in soft tissue, a single through-and-through-suture of tantalum wire .003 of an inch in diameter is necessary in order to prevent separation.

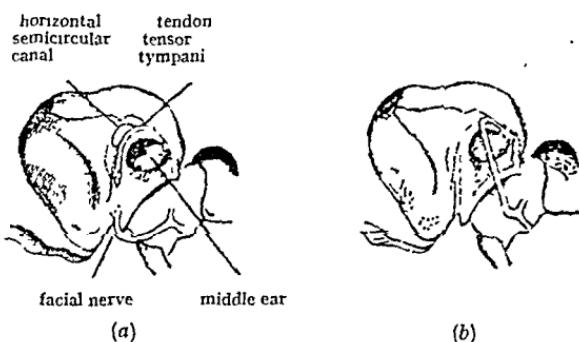


FIG. 1.—Re-routing of facial nerve : (a) Defect in facial nerve which would require nerve grafting if normal course of facial nerve was retained. (b) Defect closed and end-to-end suture accomplished by changing course of facial nerve.

(Drawing by Sergt. Felix Weinburg, 192nd General Hospital.)

A single through-and-through stitch of fine tantalum wire has been used in this series whenever it was deemed necessary to maintain the neural junction rather than several perineural sutures. It is believed that better apposition of the nerve ends is obtained in this way and that trauma incident to the passing of several sutures through the perineurium is reduced to the minimum.

Spurling (1) has demonstrated that tantalum is relatively inert in peripheral nerves and that this method of nerve suturing is practical.

Occasionally, the central end of the facial nerve is inaccessible, and as a last resort in such instances, anastomosis of the distal stump of the facial nerve with the central end of an adjacent motor nerve is essential. For this purpose the spinal accessory or hypoglossal nerves are admirably suited. Prolongation of the post-auricular incision downward into the neck along the anterior border of the sternocleidomastoid muscle permits exposure and mobilization of the central portion of either of these nerves. The peripheral end of the facial nerve is freed and the anastomosis effected and maintained by a single through-and-through tantalum wire suture. The descendens hypoglossi is sectioned and the proximal end sutured to the distal stump of the donor nerve in an effort to maintain tone in the muscles supplied by this nerve. Opinions vary as to whether the hypoglossal or spinal accessory nerve should be utilized for this surgical procedure, but as a general rule hypoglossal facial anastomosis should be reserved for those individuals whose livelihood

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depends on manual labour while spino-facial anastomosis is desirable in those whose occupation is of a sedentary nature.

There still remains the rare case in which none of the above procedures is applicable and indwelling mechanical support must be supplied to obviate the unsightly deformity of the face. Total loss of the pes anserinus or inability to locate the severed branches of the facial nerve in its facial distribution are examples. Living mechanical support may be obtained by implantation of fascia lata. This is best accomplished by undermining the skin and immediate subcutaneous tissue over the entire effected side of the face through a hockey-stick incision over the temporalis muscle and threading strips of freshly obtained fascia lata through the deeper substance of the face by means of a suitable fascial needle in such a manner as to form three loops of fascia, one each running to the upper and lower lip and the third to the angle of the mouth. It is important that the fascial loops which are incorporated in the lips extend past the mid-line. The free ends of the fascial loops are adjusted and anchored within the temporalis muscle so as to cause over-correction of the facial deformity. Excess skin is excised, the incision closed and a pressure dressing applied to the face. An excellent cosmetic result when the face is in repose may be obtained with this method and slight animation of the paralysed face may occur when the temporalis muscle contracts.

Each of these methods of treatment was employed in this series as the pathologic process present indicated and the patient's condition permitted. Decompression was performed in seven cases. Laceration or contusion of the facial nerve had occurred within the middle ear in three of these patients, in the mastoid in another and in the facial distribution in the remaining three. Approximation of the distal and proximal ends of the interrupted facial nerve was accomplished in four instances. The cervical trunk was divided in two cases and a neuroma, secondary to a fracture passing through the stylomastoid foramen, required excision in a third. The remaining patient exhibited division of two of the principal branches of the nerve in its facial distribution.

Restoration of the continuity of the divided nerve was obtained in nine cases by nerve grafting. Both fresh and pre-degenerated nerve grafts were utilized, the former on five occasions and the latter on four. The choice of a fresh or pre-degenerated graft was dependent upon the relative diameters of the facial and donor nerves. Thus, if the donor nerve was small it was crushed and allowed to degenerate for about two weeks so that the resultant increase in size of the peripheral portion would more closely approximate the diameter of the facial nerve. If, on the other hand, there was not too great a difference in the diameters, a fresh nerve graft was used.

Defects in the facial nerve ranging from 15 mm. to 50 mm. (the average being 33 mm.) were bridged in this manner. One graft of 15 mm. was utilized to repair a gap entirely confined to the cervical trunk of the facial nerve, while grafts of 26, 30, 32, and 40 mm. were used to repair losses located both in the cervical and mastoid course of the nerve. In two patients, grafts of 45 and 50 mm. replaced missing segments of the facial nerve extending from the genu to the pes anserinus. The remaining case required a nerve graft of 30 mm. to restore the continuity of the facial nerve from immediately

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anterior to the horizontal semicircular canal to just distal to the stylomastoid foramen.

The facial nerve was absent in the petrosal, intratympanic and superior half of its mastoid course on one occasion. Repair was effected in this case by anastomosis between the distal stump of the facial nerve and the central end of the hypoglossal nerve. In two cases the pes anserinus and its immediate branches could not be found and the facial deformity was satisfactorily corrected in one by fascia lata implantation. The other, together with a patient in whom the facial nerve was absent from just anterior to the horizontal semicircular canal to, it is believed, the pes anserinus, had to be returned to the Zone of the Interior before further treatment of the facial paralysis could be effected. The continuity of the nerve could not be re-established in three instances in which the interruption of the facial nerve occurred in its facial distribution.

The care of the facial musculature is important in those cases in which it is anticipated that the facial paralysis will exist for a considerable period of time. Permanent sagging of the soft tissues and atrophy of the muscles will be reduced to the minimum if mechanical support and daily massage are instituted early. Support has been obtained in this series by adhesive traction or fascia lata slings. The latter method is desirable not only because it provides more natural support to the paralysed face, but also because permanent correction of the facial asymmetry is obtained in the event functional restoration of the facial nerve fails to occur.

Exploration of the facial nerve in these cases has proven to be especially difficult due to the loss of established anatomical landmarks in relationship to the nerve in its course through the temporal bone, and also, because of the displacement of the nerve within the soft tissues of the neck and face by the wounding agent. The surgeon operating on such cases must be thoroughly conversant with the anatomy of this region and be blessed with an infinite amount of patience and perseverance.

No attempt has been made to describe the results obtained in this series as insufficient time has elapsed to permit inclusion of those cases in which interruption of the facial nerve occurred. However, since restoration of the anatomical continuity of the nerve has been accomplished in most patients, it is believed, from previously reported experience with such grafts, that relief from the facial paralysis will be obtained which will be comparable to that encountered in civil life.

### REFERENCE

- (1) SPURLING, R. GLEN (1943), "The Use of Tantalum Wire and Foil in the Repair of Peripheral Nerves", *Surg. Clin. N. Amer.*, 23, 1491-1504.

### DISCUSSION

MR. LIONEL COLLEDGE asked whether Major Lathrop was optimistic about the use of a graft 2 in. long, which had been mentioned. It was well-known that recovery would be almost certain with a graft of 5 or 10 mm. in length but different conditions arose when a graft of 50 mm. was used. Major

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Lathrop mentioned that in some cases unsuitable for grafting the facial nerve had been united to the spinal accessory. He (L.C.) thought that this operation should never be done, and that if such an operation were required the hypoglossal nerve should be used. If the spinal accessory was used discomfort and even pain in the neck and shoulder were the result, and the shoulder became weak. He had used the hypoglossal on many occasions and found the disability was slight from dividing the hypoglossal on one side. This could be minimized by dividing the descendens hypoglossi and uniting the central cut end to the peripheral end of the hypoglossal. The effect of this depended on the size of the descendens, which in turn depended upon how much of the ansa was derived anteriorly from the descendens and how much posteriorly from the cervical plexus. Sometimes the descendens was very small or even absent, but occasionally it was so large that it was possible to divide it and turn it up to be united direct with the facial, thus avoiding any division of the hypoglossal trunk.

MR. TERENCE CAWTHORNE said that an account of 40 such cases was something new in their experience, and those who had attempted this kind of work would appreciate what it meant to have done more than 20 cases over a short period of time. One question of interest was the introduction of sutures at the point of junction between the divided ends of the nerve. It had been found by Bentley and others that the introduction of suture material caused a certain amount of fibrosis however deftly it was done. It might be more desirable to use anchor sutures some distance away from the junction and to employ some such material as concentrated plasma solution for the actual join.

BRIGADIER M. L. FORMBY said that he himself had had no personal experience of dealing with these cases, but he had seen a number of them and had discussed them with the surgeons in charge. Where there was a severe lesion, involving the mastoid region, with considerable loss of facial nerve and tremendous scarring, it was extremely difficult to isolate the ends, and, having done so, to obtain a satisfactory result by grafting. Where the injury had been very severe he had been inclined to hand the case on to the plastic surgeon for restorative operations. Could Major Lathrop tell them definitely the result of his experiences in cases with extensive loss, whether he considered it justifiable to explore all cases, and whether he anticipated that a reasonable proportion would give satisfactory results? The other question was, what method did he use to protect his graft after he had put it in position?

MAJOR HOOPLE, U.S.A.M.C., endorsed the remarks of other speakers to the effect that this work should not be entered upon lightly and that perseverance was necessary. What puzzled him was the distortion which occurred. The nerve on occasion was moved by as much as an inch from its supposed location, and to search for it in its usual position, with scar tissue, and not find it, would trouble the ordinary man. It would be of interest to them all if the procedure of grafting of the nerve were elicited a little more fully.

MR. THACKER NEVILLE asked how Major Lathrop kept the patient's muscle from being stretched during recovery. He got a local optician to make a spectacle hook with vulcanite for positioning over the ear. He had found fascia lata graft a most useful and comely thing.

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THE PRESIDENT said that the great number of cases which had occurred during the war had stimulated their efforts, and no doubt would help greatly in the future towards dealing with ordinary cases in peacetime. He did not suppose that many of them would see Service cases ; these were under the care of officers in the Services. Whether there would be a number of cases left over to be dealt with after the war he did not know.

MAJOR LATHROP, in reply said that he had no definite information concerning the permissible length of the graft that might be utilized except that derived from his own past experience and that of his colleagues. The longest graft that he had used in civil life had been one of 33 mm., extending from the geniculate ganglion to about halfway to the stylomastoid foramen. Evidence of returning function of the facial nerve was first noted at the end of six months and complete voluntary control of the facial musculature on the involved side was present at the end of a year.

Whether the spinal accessory nerve or the hypoglossal nerve should be utilized in performing an anastomosis with the facial nerve should be left to the discretion of the operator. In his opinion an anastomosis does not give as satisfactory results as does end-to-end suture or nerve grafting of the facial nerve. Associated movements are more prominent and common when an anastomotic operation is used to restore function to the paralysed face than when repair of the facial nerve is accomplished by either end-to-end suture or a nerve graft. Use of the hypoglossal nerve gives rise to associated movements of the facial musculature very frequently while eating and there may or may not be some difficulty experienced in enunciation. When the spinal accessory nerve has been utilized in an anastomotic operation one often notes associated movements such as elevation of the shoulder during conversation or emotional response. There is also present decreased ability to elevate the shoulder during the course of manual labour. It would seem best, should an anastomosis be necessary, to consider carefully the vocation of the patient with relation to the possible side effects in an effort to determine whether the spinal accessory or hypoglossal nerve should be utilized.

The anatomical and pathological findings had been described in 27 of the 40 cases of facial paralysis in this series. The remaining 13 cases consisted of facial paralysis secondary to extensive lacerations of the face or cases in which it was considered inadvisable to operate because of associated wounds, of greater importance.

Major Lathrop was in agreement with Mr. Cawthorne with respect to the difficulty of operating on these patients with facial paralysis secondary to war wounds. Facility in the operative technique increased with experience and decreased the operating time. In general, such operations were lengthy and it was not uncommon to operate four or five hours only to reach such a stage in the operation as to permit completion of the surgical repair of the facial nerve at another time.

The method utilized to maintain coaptation of the nerve ends whenever end-to-end suture or a nerve graft was necessary should be left to the discretion and experience of the operator. In his opinion it was inadvisable to use a through-and-through suture of silk or cotton since sufficient foreign body

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reaction may occur about such sutures as to interfere with the downgrowth of the new neurofibrils through the suture line. It would seem preferable, when a through-and-through suture is utilized, to use an inert material such as tantalum. Colonel Glen Spurling had used a through-and-through suture of tantalum wire in the repair of peripheral nerves and had found it very satisfactory. The speaker had had no experience with the "nerve glue" to which Mr. Cawthorne referred but it might very well be the ideal method. Certainly further experience with this method of maintaining the nerve junction was justified if for no other reason than that it would minimize the trauma to the nerve ends during the necessary manipulations incident to suturing. With respect to this latter point, Loyal Davis, in a recent article in *Surgery, Gynecology and Obstetrics*, indicated that the amount of fibrosis occurring at the suture line was directly proportional to the degree of trauma sustained by the nerve ends during the process of suturing the nerve ends.

Considerable difficulty in locating the proximal and distal ends of the facial nerve was encountered in these cases of facial paralysis secondary to war wounds because of the extreme distortion present. It was a relatively simple matter to perform the necessary bone work on the mastoid process but, as a result of the large amount of granulation tissue present in the wound if two or three weeks had elapsed since it was incurred, considerable difficulty was experienced in locating the ends of the facial nerve. In such instances it was necessary to "pick up" the facial nerve at a point external to the wound, in so far as this was possible, as the relationship of the facial nerve to the existing anatomical landmarks was less likely to be disturbed. The greatest difficulty was experienced in locating the distal end of the nerve. Frequently the pes anserinus was displaced by the wounding agent and thus might lie either inferior, superior or superficial to its normal position. As a general rule, it was necessary to spend the best part of an hour in discovering the distal segment of the facial nerve.

The post-operative care was simple. In the past it had been the practice of the pioneers in the surgical treatment of facial paralysis to cover the nerve graft with gold leaf. However, he believed that this procedure had since been abandoned. It had been his custom to cover the graft in the facial nerve, when it lay in the mastoid cavity, with a piece of sterile cellophane which in turn is covered with lightly packed vaseline iodoform gauze. The gauze packing and the cellophane are removed at the end of a week. Some difficulty might be experienced in locating and removing the cellophane since it was transparent. At this time the mastoid cavity was usually found to be lined with granulation tissue and the nerve graft cannot be observed although, at times, a thin reddish streak might be noted where the graft should exist. In the event that the nerve graft was located in the soft tissues of the neck it was not covered with cellophane as the soft tissues afford sufficient protection.

It was difficult to answer the question as to whether the facial nerve should be explored in every case of facial paralysis secondary to war wounds. It would seem, if one was reasonably certain that the facial nerve had been sectioned, that exploration of the facial nerve was the only logical way in which to determine definitely whether such was the case or not. An endeavour should be made to effect restoration of the continuity of the nerve whenever possible.

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The question was asked by Mr. Thacker Neville as to how stretching of the facial musculature was prevented. It has been the writer's practice in the most recent cases to thread strips of fascia lata through a "hockey-stick" incision over the temporalis muscle on the same side as the facial paralysis, from the upper and lower lips as well as from the angle of the mouth to the temporalis muscle by means of a long, large-bore, steel needle incorporating a loop of steel or brass wire, as had been demonstrated on the blackboard. This procedure took about an hour to perform and gave rise to very little reaction and an excellent cosmetic and supportive result.

In conclusion, Major Lathrop said that he did not believe that any of these operative procedures should be attempted by the beginner. The initiate should act as an assistant until he was thoroughly familiar with the anatomy of the region and the variations encountered. Fortunately, most of these cases were "clean" but he did not believe that the presence of a low grade infection was a serious deterrent whenever it was found necessary to use a nerve graft in order to effect the anatomical continuity of the facial nerve.

# BRITISH ASSOCIATION OF OTOLARYNGOLOGISTS

## ANNUAL REPORT OF COUNCIL, 1943-4

THE British Association of Otolaryngologists was founded at a meeting held at the house of the Medical Society of London on September 10th, 1943 and nominations were made for the posts of Officers and for membership of the Council. At the first Annual General Meeting held on November 5th, the Officers and members of the Council who had been nominated were declared elected. 180 candidates for Membership whose applications had been approved by a temporary Committee appointed for the purpose were also declared elected and a preliminary list of Rules was agreed to. It was also agreed that there should be an annual subscription of £1 which it is hoped will be paid by Banker's Order. Notification of the formation of the Association was sent to various official bodies and learned societies. Many congratulatory letters were received from these bodies and it was intimated that the formation of the Association was welcomed. An article describing the aims and the constitution of the Association was published in the *Journal of Laryngology and Otology* of October 1943 and was followed by a large number of applications for Membership. These were considered by the Council and as a result the election of Members at the recent Special General Meeting brought the total membership up to 224.

The Secretariat of the Association is now housed, together with that of six other similar bodies, at 45 Lincoln's Inn Fields. The premises are owned by the Royal College of Surgeons and the accommodation includes an office, a committee room and a strong room. The Joint Secretary of these Associations is Miss B. M. Key, who after working in the offices of the Royal Society of Medicine had been for many years the Secretary of the Faculty of Radiologists and has great experience in the needs and conduct of a specialist association.

A request was received from the General Medical Council for information as to the Association's view on the training and education which would be required for the Consultant of the future and for comments on other matters connected with a register of Specialists and Consultants. A report was furnished incorporating extracts from the Memorandum sent to the Inter-departmental Committee on Medical Schools by the *ad hoc* Committee of the Sections of Laryngology and Otology of the Royal Society of Medicine. The Hon. Secretary attended a meeting of the Joint Academic Council of the three Royal Colleges, the Universities and various professional bodies when a resolution disapproving of a statutory register was passed.

The Royal College of Physicians, having been empowered to revise the "Nomenclature of Diseases", requested the Association to nominate two members to serve on the Committee. Mr. Mollison and Mr. Colledge were elected to represent the Association on the Committee.

Mr. Negus was appointed the representative of the Association on the "Beveridge" Committee of the three Royal Colleges, on which the B.M.A.

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and consultants throughout the country are represented, and which has been formed for discussion and action in regard to the White Paper on a 'National Health Service.' He also represented the Association at meetings held at the Royal College of Surgeons on this matter and also on matters connected with the report of the Interdepartmental Committee on Medical Schools. A memorandum was sent to the President of the Royal College of Physicians at his request on the subject of the White Paper.

It had been intimated by the President of the College of Surgeons that he and the Council would welcome a member of the Association on the Council. Mr. Negus was asked by the Council of the Association to allow his name to be put forward as a candidate for election to the Council of the College. He was nominated for the election held in 1944. There was a large field for three places on the Council and two well-known members of the Council were candidates for re-election. Mr. Negus polled over two hundred votes and attained a high position in the ballot, but did not obtain a place on the Council. The Council of the College decided to co-opt representatives of a number of specialties and Mr. Negus was invited to represent Otolaryngology pending permission from the Privy Council for formal co-option. He has attended all the meetings of the Council since and expressed the views of the Association. Mr. Ewart Martin has been empowered to represent the view of the Association at meetings of the Royal College of Surgeons of Edinburgh.

At the request of Mr. Sydney Scott the Council of the Association has taken over the functions of the British Organizing Committee for International Congresses in Otolaryngology and the balance of the funds of that Committee has been transferred to the Association and has been earmarked for use in connection with any future International Congress.

The Council is concerned as to the shortage in many parts of the country of Otolaryngologists which will become worse in the near future, because of the inevitable retirement of many who are at the present moment in full active practice. During the past five years very few prospective members of the specialty have been enabled to commence their training owing to the urgent calls of the medical branches of the Services and a memorandum has been presented to the Central Medical War Committee setting out these facts and putting forward suggestions for increased facilities for the training of specialists in Otolaryngology.

A revision of the regional distribution of members of the Council was put forward by the Council at a Special General Meeting on December 1st, 1944 and was embodied in the Rules. It is hoped that by this new distribution the whole country will be proportionately represented and it will make possible the periodical retirement of members and the election of new ones without altering the balance of representation.

A sum of 25 guineas has been sent to the Royal College of Surgeons of England as a first donation to the rebuilding and re-equipment fund. A Committee has been formed by the College for the re-establishment of the Hunterian Museum and the Association is represented on this Committee.

Messrs. Howard, Howes & Co., were appointed auditors to the Association, and the balance sheet showed a balance at the end of the financial year of £104 12s. 11d.

# The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

July 1945

## THE MASKING EFFECT OF SULPHONAMIDE WHEN USED IN THE TREATMENT OF ACUTE OTITIS MEDIA

By I. MALCOLM FARQUHARSON (Edinburgh)

IT has been claimed, and I think rightly so, that the discovery of the sulphonamide group of drugs has been the greatest advance in therapeutics of this century, with of course the possible exception of the more recently introduced penicillin.

In the past, when any new drug was discovered it was generally recognized that a period of some ten years would have to elapse before it could be claimed that the mode of action and any side effects were fully understood.

On the introduction of sulphonamide, however, this interim period was thought to be no longer necessary as, with an exact knowledge of the drug's chemical formula and the advance in biological experiments, a comprehensive and exact perception of the action of the drug, with any toxic properties it might possess, would be at our disposal.

Time has shown, however, that this hypothesis was not quite justified. When applied to acute infections of the middle ear it is incorrect.

Lulled into a feeling of false security by the preliminary reports on the drug, the medical profession have had a rude awakening.

I am deeply indebted to Dr. Ewart Martin for permission to review the cases of acute otitis media occurring in the wards of the Edinburgh Royal Infirmary under his charge from 1937, when sulphonamide was first introduced here, to the end of 1944. The cases occurring in the eight years previous to this were taken as a comparison.

Comparing the pre-sulphonamide with the sulphonamide cases it will be seen that in the former, 29 per cent. of cases of otitis media developed mastoiditis as compared with 13 per cent. in the latter.

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From these figures, which have been reported at a previous meeting, it will be noted that there has been a quite definite reduction in the number of cases requiring simple mastoidectomy. It should be pointed out that this reduction of mastoid involvement occurs in the 29 per cent. group rather than in the 71 per cent. that formerly resolved spontaneously. If we agree that our usual clinical methods were responsible for the curing of 71 per cent. of cases, it must be obvious that to attribute all cures to sulphonamide would be quite fallacious.

TABLE I

	Acute Otitis Media.	Mastoid as Complication.	Intracranial Complication.	Death.
		Per cent.		
1932	198	69 (34.8)	5	1
1933	243	94 (38.6)	10	4
1934	244	73 (29.8)	11	3
1935	243	56 (23)	9	2
1936	266	62 (23.3)	4	1
<i>Sulphonamide :</i>				
1937	222	40 (18)	2	1
1938	224	33 (14.7)	6	2
1939	226	31 (13.7)	1	1
1940	203	32 (15.7)	2	0
1941	168	13 (7.7)	2	2
1942	178	26 (14.3)	2	1
1943	169	23 (13.6)	3	1
1944	130	17 (13)	2	1

For some time now the Otologist has been aware that a change in the once familiar signs and symptoms of acute mastoiditis can occur after the administration of one of the sulphonamide group of drugs.

The drug, by its marked analgesic and antipyretic properties, tends to obscure the clinical picture, often giving rise to a latent course of the disease that is responsible for the overwhelming pathological changes we so often see.

It is a matter for profound meditation that the drug which has produced such miracles in the treatment of otitic meningitis is the same drug which, used misguidedly, is indirectly responsible for the development of the disease itself; by masking symptoms that would have indicated surgical intervention.

The exhibition of sulphonamides is liable to change the ordinary case into an infection which is identical with that produced by the *Pneumococcus* Type III; furthermore, how significantly altered must be our judgement, when the two factors are combined, namely, the insidiousness of the *Pneumococcus* and the masking effect of the sulphonamide.

## Sulphonamide in Treatment of Acute Otitis Media

At this juncture the masking effect of the drug must be mentioned when used after operation to control a febrile reaction, the cause of which had not been diagnosed.

Complications when they did occur, were either completely hidden or sufficiently masked to distort the criteria for more extensive surgery.

For this reason, therefore, following simple mastoidectomy the drug should not be given in uncomplicated cases.

In the case of lateral sinus thrombosis or petrositis, the limit of surgical measures must be reached before the drug can be safely given.

In the last eight years appreciable deterioration in hearing has been noticeable in the cases of otitis media passing through the Out-Patient Department. In the absence of other factors this must be put down to the masking effect of the drug causing delayed drainage from the middle ear. This may promote an adhesive inflammatory change or, as suggested by Kopetzky, may be due to a hydrops of the labyrinth due to a chemical reaction between the perilymph behind the oval and round windows and the purulent contents of the middle ear. Promptness in relief of this hydrops by drainage of the ear alone saving the hearing, as, if delayed, permanent changes may occur in the cochlea.

Cases of acute otitis media are now arriving at the Out-Patient Department much later than they used to, indeed a number of cases seen are those which have failed to be cured by the "box of white tablets and ear drops" supplied by their doctor. For this reason operative drainage has occurred as late as 3-4 months after the acute attack.

This has also increased the number of cases which have developed chronic otitis media.

This altered clinical and pathological picture can best be illustrated by quotations from clinical case records.

### CASE NO. I.

*Comment:* This case illustrates the effects of the unguided use of the drug, the progression of the infection with no symptoms referable to the ear. The infection has been changed into one associated with a *Pneumococcus* type III. On otoscopy the appearances of the drum would suggest that of a subacute infection and certainly would not suggest the marked destruction of mastoid found at operation.

The special affinity for dural plate should be noted.

### CASE NO. II.

*Comment:* Here the disease progressed in spite of adequate dosage or maximum dosage permissible due to toxic manifestations, one month after cessation of drug.

Likewise the peculiar "mottled" appearance of the mastoid, indicating that the infection had only been partially controlled, due

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possibly to thrombosis of the vessels and the fact that the drug only reached certain areas of the mastoid.

Special affinity for sinus plate and resulting sinus thrombosis.

## CASE No. III.

*Comment:* This case showed the hazard of giving Sulphonamide to control a temperature after operation the cause of which had not been diagnosed, so masking the clinical picture of the meningitis present.

## CASE No. IV.

*Comment:* The case demonstrates the way the drug toxæmia may mimic inflammatory spread of the disease, and how the clinical facts were misinterpreted.

## CASE No. V.

*Comment:* This case records a success for the drug some two weeks after the commencement of infection after totally inadequate dosage. The wisdom of the administration of the drug at that stage might well be questioned.

## CASE No. VI.

*Comment:* This case is the only one in which definite destruction of the mastoid was found in the presence of negative X-ray findings.

The peculiar appearance of the bone, resembling non-sequestrated dead bone, also the cells devoid of mucous membrane or granulations.

The extreme degree of deafness in spite of operative drainage, also the persistent loss of hearing by bone conduction suggests a hydrops of the labyrinth as already mentioned may be an ætiological factor, drainage being too late to conserve auditory acuity.

## CASES No. VII AND No. VIII.

*Comment:* Examples of a type of case seen almost every day in the Out-Patient Department.

In Case No. VII the doctor had forgotten the occurrence of the acute otitis media and sent the patient up for investigation of hearing. Pus was found behind the drum and condition settled down on incising the drum.

The hearing, however, did not return to normal on inflation, due to adhesive inflammatory change.

Case No. VIII is very similar, the drug being employed as the only treatment, paracentesis not being carried out at the start. Fortunately, hearing returned to normal after inflation in this case as it was of shorter duration than Case No. VII.

In the absence of clerical assistance and in view of the impossibility at present of recalling patients for re-examination, it has not been found

# Sulphonamide in Treatment of Acute Otitis Media

feasible to give definite figures of the incidence of masking and subsequent permanent deafness since the introduction of sulphonamides. It can, however, be affirmed that one case is seen on every Out-Patient day at the Royal Infirmary.

## Clinical Characteristics

✓ As can be appreciated from a study of these cases, the whole picture of acute otitis media has undergone a change in the last few years. One must now learn the signs and symptoms of what Theodore Welsh has termed "the otitis media-sulphonamide compound syndrome".

To evaluate properly this atypical disease, all diagnostic aids at our command should be employed.

*Aural Discharge* : Variable, scant or moderate with profuse drainage on discontinuing the drug. It may be sterile.

*Otoscopy* : Tympanic membrane thickened, with alteration of usual anatomical landmarks, sagging of roof and herniation of drum frequently absent.

*Mastoid tenderness and pain* : Usually absent.

*Temperature* : Here the drug perhaps causes its greatest masking effect. Following administration, the temperature falls. This may be followed by irregular elevations, the true cause of which may be difficult to discern. It may be due either to drug sensitivity or further invasion of infection.

When the drug is given only for 7-10 days this difficulty is diminished.

The characteristic variations associated with invasion of meninges and lateral sinus may be absent.

*X-ray Examination* may be required more frequently, especially as a check up on the progress of the infection.

Law and others have pointed out that the introduction of Sulphonamide has confronted the Radiologist as well as the Otologist with new and difficult problems.

The appearance of the films indicate that the mastoiditis is not as severe as clinical evidence would suggest. The drug appears to do something to the contents of the cells whereby they become more translucent to the X-rays. The use of stereoscopic films are essential if any guidance is to be obtained from them.

A note of warning is necessary, therefore, against putting too much dependence on X-ray findings to clarify a picture already confused by sulphonamide.

*Blood Picture* is naturally altered and examination is best employed as a check against the toxic action of the drug. Symptoms of systemic upset as chills, headaches and cerebral disorientation are also explained as possible toxic phenomena.

The pathological processes of infection of the middle ear as altered

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by use of the drug have been well demonstrated by the cases already shown.

The peculiar feature is the fact that the infection appears to be only partially controlled, areas of softening and abscess formation being surrounded by normal bone or organization and new bone formation; other areas resemble non-sequestered dead bone.

Of special interest is the special affinity that the disease has for the dural and sinus plates, extradural and perisinus abscesses being a natural sequence.

Up to now factors have been considered which have caused masking and lack of control of infection in the light of the peculiar pathology of the mastoid process, other factors of equal importance are present which operate in all cases under treatment with sulphonamides.

i. The sulphonamide concentration should be maintained at a blood level of at least 10 mg. per 100 c.c. blood.

Deficient gastro-intestinal absorption and vomiting may give rise to difficulties in maintaining this concentration.

ii. The drug is free to act upon infection wherever it can be conveyed by blood stream. Therapeutic results cannot be expected in areas of undrained pus or necrosis surrounded by thrombosed vessels.

iii. The presence or absence of anti-bacterial antibodies.

For some time it has been realized that a patient may recover from a haemolytic streptococcal infection without developing an anti-bacterial immunity, the body localizing the infection and recovery occurring when the abscess is drained.

When chemotherapy is given to such a patient it may arrest the infection. If, however, it is not continued long enough or the dosage is inadequate or it cannot reach the infected area, the infection may light up again, the patient having failed to acquire antibodies subsequently.

This may account for a number of the cases of progression of infection and complications.

It has been said the sulphonamides, when given early in the infection, may hinder the production of anti-bacterial immunity; upon this point there is no general agreement.

iv. Coexistent erythrogenic toxæmia of scarlet fever.

v. Drug toxæmia producing an early termination of therapy before infection has been arrested. As evident in Case No. 4, it may mimic inflammatory spread.

From this altered clinical and pathological picture it will be evident that operation will be deemed advisable with fewer symptoms and signs than when the case was unaltered by the administration of sulphonamide.

I should like to suggest for your consideration the following scheme for the treatment of a case of acute otitis media with sulphonamide:

# Sulphonamide in Treatment of Acute Otitis Media

1. Hospitalization for all cases.
2. Confinement to bed during the treatment.
3. Adequate dosage, at the present time Sulphadiazine due to its potency and low toxicity.

Maintenance of a blood concentration of at least 10 mg. per 100 c.c. blood.

At the Royal Infirmary we employ, what Lyon has called a "chemo-therapeutic blitzkrieg", in an effort to conclude treatment in 7 to 10 days for the reason already indicated.

This assumes that in a haemolytic streptococcal infection a definite improvement is seen in 12 hours and normal temperature and apparent arrest of infection in 48 hours.

The continuance of a purulent discharge from the middle ear after a week of adequate medication from the beginning should be sufficient evidence that it has not been controlled; in continuing the drug we would assume a grave responsibility.

4. Early paracentesis, to relieve tension, is of course of special importance. A culture should be taken of the discharge at same time.
5. In virulent infections the determination of the presence or absence of antibodies.

In spite of the administration of the drug in adequate doses and other measures, mastoiditis will develop in a certain percentage of cases.

The final decision as to whether sulphonamide is to be given to a case of acute otitis media rests on the ability or otherwise of the otologist to carry out the treatment along the lines suggested.

If this cannot be assured the drug should be withheld, as the risks of turning a simple condition into a dangerous one are too great.

The general practitioner must be discouraged from treating acute otitis media with the sulpha group of drugs, unless he takes the responsibility of observing the case from day to day on a 4-hourly chart.

## CASE NO. I

**HISTORY.** Girl of 8 years, had attack of earache when evacuated: treated with sulphonamide and condition cleared up and was forgotten. Six weeks later parents brought child home as she looked ill, thin and pale. Girl's only complaint—tiredness and headaches. A week later developed febrile illness, with signs of meningitis. She was admitted to hospital.

*Lumbar puncture* showed C.S.F. turbid and under pressure: on culture a haemolytic streptococcus was isolated.

In view of this finding, an aurist was called in to report upon the condition of the ears.

**O.E.** Right Ear showed thickening of drum with obliteration of landmarks: no discharge: no mastoid tenderness or swelling.

Left Ear—normal drum.

Conversation voice heard at contact right ear.

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X-RAY OF MASTOIDS. Marked destruction of mastoid cells.

OPERATION. Destruction of whole of mastoid, especially dural plate, where the tegmen was found lying as a sequestrum. Extradural abscess present. Dura mater tense and congested.

TREATMENT. Sulphapyridine given, 1 gm. I.M. 4-hourly and 1 gm. 4-hourly orally.

The meningitis spread and the child died.

## CASE No. II.

HISTORY. Boy of 7 years, developed otitis media and treated with 80 grains of Sulphathiazole daily for 2 weeks. Drug stopped owing to toxic rash and fact that middle-ear condition appeared to have resolved. A month later otitis media flared up and patient admitted to hospital.

O.E. *Left Ear*—drum red and bulging with small posterior perforation with pulsating discharge. Slight mastoid tenderness.

*Right Ear*—drumhead normal.

Whispered voice heard at 18 inches left, 10 feet right.

OPERATION. Mastoid showed a strange "mottled" distribution of the disease. Areas of softening and abscess formation surrounded by normal bone; in others granulation tissue showing evidence of healing and new bone formation.

Sinus plate was necrosed, with perisinus abscess and thrombosis of the lateral sinus.

Lateral sinus was opened up and free bleeding obtained from both ends of sinus. *Pneumococcus Type III*.

Post-OPERATIVE. Uninterrupted recovery without requiring sulphonamide therapy.

## CASE No. III.

HISTORY. A woman of 22 years. Admitted with acute otitis media. Drum was incised. Ten days later developed mastoiditis.

OPERATION. Mastoid cells filled with pus but little breaking down of cells.

POST-OPERATIVE COURSE. Patient had sustained febrile reaction which was not accounted for and was put on sulphonamide for first time. Two weeks later, owing to pain over her eyes, mastoid re-opened and petrous investigated but no tract found. Dura under tension, upon being elevated there was a gush of pus. Temporal lobe abscess sought but not found.

Lumbar puncture showed high cell count but no organisms.

During subsequent dressing, temporo-sphenoidal abscess found and drained.

Recovery of patient.

## CASE No. IV.

HISTORY. Boy, aged 10, developed otitis media: paracentesed and given 80 grains of Sulphapyridine daily for 18 days. Developed swinging temperature of  $100\cdot4^{\circ}$  F.

O.E. Boy pale, toxic looking: tongue furred: some dehydration: drowsy and lethargic.

*Left Ear*: posterior perforation, scanty purulent discharge.

# Sulphonamide in Treatment of Acute Otitis Media

*Right Ear*: drum normal.

*Hearing*: Whispered voice heard 2 feet left, 10 feet right. Rinne neg. left, pos. right.

*W.B.C.*: 4,500.

**OPERATION.** Difficulty experienced with anaesthetic due to poor oxygen carrying capacity of blood due to the drug.

On opening mastoid, no pus found : mastoid not completely pneumatized : no bone necrosis.

**POST-OPERATIVE.** Convalescence protracted. Given blood transfusion—1 pint.

## CASE NO. V.

**HISTORY.** Boy aged 10 years, developed acute otitis media : Doctor gave 0.5 gm. Sulphamethazine t.i.d. for 10 days ; not confined to bed.

Temperature 100° F. and pain in ear at end of that time.

*O.E. Right Ear*: Drum red but not bulging, dry.

*Left Ear*: Drum normal.

*Hearing*: Whispered voice heard 4 feet right ear, 13 feet left.

**TREATMENT.** Drug stopped, confined to bed : inhalations. No further pain : temperature normal.

Five days later, severe pain in ear, temperature 101° F.

*O.E. Right* drum red and bulging : pus on paracentesis.

Two days later temperature 101° F. : profuse discharge from ear : mastoid tenderness : whispered voice heard at 2 feet right ear.

**TREATMENT.** Given 2 grams and 1 gram 4-hourly of Sulphathiazole for five days ; by 24 hours all pain gone and temperature normal ; by 48 hours ear dry ; by fourth day whispered voice heard at 6 feet, right ear.

## CASE NO. VI.

**HISTORY.** A man of 45 years with left otitis media following cold. Four days later, paracentesis performed and pus obtained. Given 6 grams Sulphapyridine daily for one week, by which time ear dry.

A month later the ear started to discharge again, without a fresh cold. Patient admitted to hospital.

*O.E. Left Ear*—Drum thickened, opaque, with obliteration of landmarks : slight discharge : some mastoid tenderness.

Heard conversation voice at 18 inches : hearing by bone conduction reduced.

*X-ray* did not show definite signs of mastoid involvement—reported as negative.

**OPERATION.** Pus obtained : mottled distribution of disease evident : the expecta of cells containing pus found devoid of mucosa and resembled dead bone. Epidural and perisinus abscess present.

**POST-OPERATIVE.** Good recovery. In spite of inflation of Eustachian tube, hearing not improved beyond conversation voice heard at 3 feet : hearing by bone conduction reduced.

Refuted any deafness before illness.

# I. Malcolm Farquharson

## CASE No. VII.

An example of a type of case seen almost every Out-Patient day.

HISTORY. Doctor sent patient up with history of deafness for three weeks following pain in ear for which two tablets of a sulphonamide were given 4-hourly. Following syringing of ear for wax, two weeks ago, no improvement in hearing. Age 32.

O.E. *Right Ear*: Drum pink and thickened : dry.

*Left Ear*: Drum normal.

*Hearing* : Whispered voice at 8 inches right, 8 feet left. Rinne neg. right, positive left : no reduction in bone conduction.

Paracentesis performed and pus obtained : *haemolytic streptococcus*.

Ear dried up on conservative treatment. After inflation of Eustachian tube, whispered voice was not improved beyond 3 feet.

## CASE NO. VIII.

HISTORY. Pain in ear two weeks ago: given Sulphathiazole by doctor. Ear did not discharge. Has become deaf since then.

O.E. *Left Ear*: Drum thickened, pus lying behind it. Dry.

*Right Ear*: Normal drum.

*Hearing* : Whispered voice heard 1 foot left.

*Paracentesis* : pus.

Discharge ceased after one week. After inflation, heard whispered voice at 8 feet.

# OTO-RHINO-LARYNGOLOGY IN THE NAVY

By H. D. BROWN KELLY (Glasgow), Surgeon Lieut.-Commander, R.N.V.R.  
THIS paper presents an analysis of 5,000 cases examined in the Ear, Nose and Throat Department of a Royal Naval Auxiliary Hospital. Included in this number are consultation cases from all parts of Scotland, patients admitted for treatment or operation, and also those referred for examination from other departments of the hospital.

It will be noted that unusual and interesting cases were seldom encountered. This is natural considering that we are dealing with selected personnel, both as regards age group, and as regards a certain standard of fitness on entering the Service. Diseases peculiar to the later decades of life, e.g., carcinoma, are therefore rare. The small number of women, and the absence of children, make comparisons with a civilian clinic impossible.

All cases could be roughly classified as follows :

Per cent.

Diseases of the Ear .. .. ..	2,196	43·9
Diseases of the Nose .. .. ..	1,454	29·1
Diseases of the Pharynx .. .. ..	923	18·5
Diseases of the Larynx .. .. ..	117	2·3
Negative Examinations .. .. ..	310	6·2
(for fitness, to exclude sepsis, etc.)		
	<u>5,000</u>	

It may be of interest to compare these percentages with those obtained in an Army Hospital. Birrell (1944) has recently reviewed Ear, Nose and Throat work in the Army at home and overseas. Out of 4,000 unselected cases, he found 57 per cent. were aural, 23·5 per cent. nasal, 10 per cent. pharyngeal, 3 percent. laryngeal and 6·5 percent. miscellaneous. The difference in the number of pharyngeal cases is accounted for by the fact that few tonsillectomies were performed in the Army establishment.

## i. EXTERNAL EAR Diseases of the Ear

Cerumen .. .. .. ..	190
Furunculosis .. .. .. ..	89
Otitis Externa .. .. .. ..	213
Traumatic Stenosis .. .. .. ..	2
Exostosis of Meatus .. .. .. ..	4
Hæmatoma of Auricle .. .. .. ..	1
Cyst of Auricle .. .. .. ..	2
Carbuncle of Auricle .. .. .. ..	1
Rodent Ulcer of Auricle .. .. .. ..	1
Herpes Oticus .. .. .. ..	3
	<u>506</u>

# H. D. Brown Kelly

## FURUNCULOSIS AND OTITIS EXTERNA

Furunculosis of the external auditory meatus occurred in 89 instances. Especially when associated with the presence of boils elsewhere, local treatment must be supported by attention to the general health and by the administration of vitamins.

Cases of diffuse otitis externa unassociated with middle-ear disease numbered 213. Many of these originated after bathing in the Mediterranean or other Eastern waters, and for years afterwards showed periodical exacerbations.

In the treatment of this condition the first essential is absolute cleanliness of the ear. All epithelial débris and inspissated pus must be removed by syringing and careful mopping. Adherent dead skin may require loosening with the probe and picking out with forceps. Once thoroughly clean, no water should be allowed near the ear. The use of hydrogen peroxide is to be avoided, as it exerts a caustic action on the skin, especially when used for long periods.

If the external canal is narrowed by swelling, a strip of narrow gauze soaked in glycerine of carbolic or 1 per cent. aluminium acetate is packed gently into the ear and allowed to remain there for six to twelve hours. At the end of that time, the canal will usually be found sufficiently widened to enable cleansing of the deeper parts to be carried out. When the ear is quite clean and the drum-head details are visible, sulphathiazole cream 5 per cent. on fine gauze is inserted. This dressing is changed daily.

Occasionally a case was encountered which did not improve, or which even got worse with the sulphathiazole. Such often responded well to an oily solution of Ung. Hydrarg. Nit. Dil.

Many patients were found to have an associated seborrhœic condition of the scalp. This required treatment by washing the head with spirit soap, and the daily application of spirit and salicylic acid lotion.

In ten cases, the otitis externa was secondary to impetigo of the face and scalp.

## 2. MIDDLE EAR

Acute otitis media	..	..	..	114
Acute mastoiditis	..	..	..	40
Chronic suppurative otitis media	..	..	..	936
Obstruction of Eustachian Tube	..	..	..	200
Middle-ear Deafness	..	..	..	119
				—
				1,409

# Oto-Rhino-Laryngology in the Navy

## ACUTE OTITIS MEDIA AND MASTOIDITIS

Out of 114 cases of acute otitis media, 40 developed acute mastoiditis and required operation. In these days of sulphonamide therapy, this may seem a large percentage, but the matter is easily explained. Many cases of otitis are treated in sick-bay, sick-quarters or hospital ship, and a large number of those admitted to hospital had failed to respond to treatment elsewhere.

One case in particular is worth recording. A Norwegian rating aged 26, developed an acute left otitis media 14 days previous to his admission to hospital. He had been treated in a hospital ship with glycerine and carbolic drops, sulphathiazole 25½ gm., sulphanilamide 7 gm., and 252,000 units of penicillin intramuscularly. On his admission, paracentesis of the left membrane was performed, and he was watched carefully for seven days, during which time his pulse and temperature remained normal. Pain in the ear persisted despite apparently adequate drainage through the drumhead, and some sagging of the meatal roof became apparent. On opening the left mastoid, it was evident that considerable bone destruction had occurred, the dura of the middle fossa and of the lateral sinus being exposed. After completion of the cortical mastoidectomy, no further chemotherapy was instituted. Convalescence proceeded uneventfully, and he was discharged with a dry ear and intact tympanic membrane on the 24th day after operation. The manner in which the varied chemotherapy had obscured the clinical picture without arresting the disease is of interest.

## CHRONIC SUPPURATIVE OTITIS MEDIA

Patients treated for aural disease numbered 2,197, and of these 936 (42.5 per cent.) were found to have chronic suppurative otitis media. This condition was by far the commonest of ear complaints, and accounted for the greatest loss of Service time. Up to May, 1945, the number of patients invalidated on this account was surprisingly small, being 94. Bilateral otorrhoea unlikely to clear up with conservative measures (e.g. attic suppuration) or severe accompanying deafness, usually demanded survey.

Formerly the running ear was a bar to entering the Navy, but when the man-power problem became acute, it was found to be quite impossible to disqualify the thousands who suffered from this complaint. It was decided to allow men with chronic ear disease to serve, provided they were graded according to fitness for shore service only, sea service in large ships carrying a medical officer, or in small ships.

The rating with C.S.O.M. is always a potential source of trouble.

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Exposure to cold, or the entry of water into the ear may cause an acute exacerbation of the disease and give rise to anxiety if he is far from specialist advice.

Cases associated with attic disease or polypus formation which were considered unfit for sea, and to be kept within reach of an aurist numbered 297. Of these 94 were invalidated and 96 underwent radical mastoidectomy. Removal of aural polypi in 50 cases, and conservative treatment of attic disease in 38 enabled the men to return to duty.

### TREATMENT

Conservative treatment of C.S.O.M. consists firstly in obtaining a clean ear. Syringing, repeated if necessary after the instillation of hydrogen peroxide to loosen inspissated secretion, is usually sufficient to obtain this. Occasionally hardened crusts and cholesteatomatous débris must be removed with probe and forceps.

The ear is then inspected, and polypoid tissue or granulations are removed with the snare, ring knife or by the application of silver nitrate solution. Gentle use of the probe will reveal any carious bone. Thorough mopping of the ear is then followed by inflation of the Eustachian tube, and the removal of any fluid blown out of the middle ear.

Further treatment depends on the conditions found. If the perforation is large, and the secretion not too profuse, the insufflation of boric and iodine powder is often of benefit. Sulphathiazole powder may be used instead, although there is doubt that this is much more efficacious than the older remedy, and it tends to cake.

Should there be granulation tissue present, after dealing with the main mass by means of curetting or silver nitrate, spirit drops may be used twice daily. It is essential that any secretion be removed from the ear before instilling the drops—a point that is often overlooked when the treatment is relegated to the patient himself or to an insufficiently trained nurse.

The use of mercurochrome drops is deplored, especially when the case is liable to be transferred to another establishment. The red colour effectively obscures any redness due to inflammation and may even confuse the landmarks.

When the aural discharge is due to Eustachian tube infection, or has its origin in the tympanum, and there is no obstruction to drainage, it will frequently clear up with conservative treatment. A proportion of these cases, however, fail to do so, and may be permitted to carry on with full duty provided they receive careful instruction in aural toilet, and report to their medical officer in the event of any pain or discomfort.

# Oto-Rhino-Laryngology in the Navy

Those with attic disease or cholesteatoma should undergo radical mastoidectomy. Radical operation rarely renders a man fit for sea service, and the official view is that it should not be performed except in the case of highly trained or key ratings. Others are usually invalidated.

All patients with actively discharging ears were seen twice daily, once by the surgeon, and again in the evening by a specially trained nurse. The hospital was fortunate in being allowed to retain the services of a V.A.D. who remained in the department for five years and became skilled in the use of forehead mirror and aural speculum. The regular attention was the foremost factor in obtaining a dry ear in many cases.

## RADICAL MASTOIDECKOMY

Of the 936 cases of chronic suppurative otitis media, 96 underwent radical mastoidectomy, and of these 82 were eventually surveyed as unfit for service afloat.

The great disadvantage of this operation from the Service standpoint is the length of time required in hospital. In civilian life, the patient may be discharged at the end of two to three weeks, and attend as an out-patient for further dressings without interfering unduly with his occupation. The Service case has to stay in hospital until the mastoid cavity is completely epithelialized and requires no further attention beyond periodical inspection and cleaning. He may therefore have to remain an in-patient for six or eight weeks, depending on the rapidity of healing. He becomes bored, and acquires that "hospital mentality" which may affect his outlook on return to duty.

The Service specialist has to achieve a difficult compromise between doing what is best for the patient, and how best to serve the demand for man-power.

The effect of penicillin on the healing of radical mastoid cavities was observed. After removal of the initial packing on the fifth day after operation, the cavity was packed with gauze soaked in penicillin, 1,000 units to the c.c. The dressing was changed daily. In infected cases a diminution in the amount and foetor of the discharge was observed, but apart from this, no particular advantage accrued. There was indeed a tendency to increased granulation tissue formation.

Cases with aural polypi were usually sent in to hospital with the recommendation for radical mastoidectomy. Removal of the polyp and careful treatment of the point of origin with 30 per cent. silver nitrate was often found sufficient to render a man fit for duty in ships carrying a medical officer. When the polyp arose from the posterior meatal wall, a dry ear usually resulted from this conservative treatment. If springing from the attic region, however, a polyp demands radical operation.

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## 3. INNER EAR

Nerve deafness .. .. .. ..	104
Concussion deafness .. .. ..	84
Otosclerosis .. .. .. ..	25
Ménière's syndrome .. .. ..	4
Congenital deafness (islands of hearing) ..	1
	—
	218
	—

## 4. MISCELLANEOUS AURAL CONDITIONS

Tinnitus (cause uncertain) .. ..	15
Vertigo (labyrinth imbalance) .. ..	42
Hysterical deafness .. .. ..	1
Malingering .. .. ..	2
Quinine deafness .. .. ..	1
Eighth nerve neuroma .. .. ..	1
Cerebellar abscess (otitic) .. ..	2
	—
	64
	—

## DEAFNESS

The total number of patients treated for deafness was 728. Cases due to cerumen (190) or to recent Eustachian tube obstruction (200) presented no particular problem. Of the remainder, there were 119 instances of middle-ear deafness (17 severe enough to warrant invaliding) and 104 of nerve deafness (16 invalidated). In 84 cases the trouble originated from blast injury to the ear. Otosclerosis could only be diagnosed with certainty in 25 patients, and of these none was sufficiently far advanced to demand survey. In some instances, where for example the patient was a telegraphist, it was necessary to recommend a change in rating.

The degree by which a man's deafness may have been caused or aggravated by blast is often difficult to assess. Most ratings, especially those being invalidated, attribute their deafness in whole or in part to damage by gun-fire or bomb explosion. Unless there is a medical record made at the time of the alleged damage, their statements cannot always be fully accepted. It is not uncommon to find such a patient who admits to having had aural trouble as a child; or the changes visible in the ear may be obviously of longer standing than the history would lead one to believe.

## MALINGERING

No patients simulating complete bilateral deafness were encountered. Only in two cases was pure malingering as regards total unilateral deafness met with. Exaggeration of an existing hearing loss was, however, not

## Oto-Rhino-Laryngology in the Navy

unusual. If a man has definite pathological changes in the ear, and has been examined in several hospitals, he soon gets to "know the answers". Determined to be invalidated, he is very difficult to catch out. He is well acquainted with the hearing tests, and has a good idea as to what constitutes an invaliding disability.

Two common tests are useful. The first makes use of a stethoscope fitted with a funnel in place of the chest piece, and with one tube blocked. The suspect becomes confused by not knowing whether the words spoken into the funnel are being conducted to the right, the left or to both ears. The other test is carried out by inserting a Bárány noise box in the alleged sound ear, and asking the patient to read aloud. If the other ear is really quite deaf, he will raise the voice as the reading proceeds until he is shouting.

The audiometer is of great value. Few patients exaggerating deafness can remember the exact intensity at which they professed to hear sounds of various pitch. Audiograms taken at intervals of fifteen minutes will reveal a discrepancy which gives them away.

The old trick of catching the patient out sometimes succeeds. When he thinks that the examination is over, he relaxes from the very considerable strain of trying to behave in a manner compatible with the deafness simulated. When, therefore, after prolonged hearing tests, the examiner at last suddenly indicates that he is finished, and as the patient is going out of the door, suddenly calls him back by name quietly, an involuntary response is sometimes obtained. Asking the suspect in a low voice to close the eyes will often succeed. Care must be taken that the patient is not a lip reader.

Especially difficult to assess are these patients who, with definite pathological changes in the ear and a slight degree of deafness deliberately exaggerate the hearing loss in order to be invalidated. It is worth while keeping such people under observation in the wards for some time. The nursing staff is instructed to watch unostentatiously their behaviour, and how loudly the other patients speak when conversing with them. When there are several deaf patients in the ward, they like to get together and pool ideas on how to work out their salvation. It is a good plan to test a patient's hearing on the day of his admission before he has time to compare notes with his fellows.

I well remember one instance when two of my patients, conversing normally, were proceeding down a corridor unaware that I was close behind them. One turned round and saw me. The next moment they were shouting at each other.

A case of suspected malingering was proved by audiometry to be an unusual type of deafness with "islands of hearing" which suggested a congenital origin.

E.Y., aged 22, ordinary seaman, complained of intermittent discharge

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from the right ear and increasing bilateral deafness. The family history was negative as regards aural trouble.

He appeared to be a simple youth of rather low intelligence. Examination showed a dry posterior perforation of the right drum-head. The left was intact, slightly retracted and dull. The nose appeared to be patent and clean. A small pad of adenoids was present. Conversation voice was heard at six feet in the right ear. With the Bárany box in the right, a shout was just perceptible close to the left ear. It was almost impossible to get accurate or consistent results with the tuning forks, and despite his simple appearance, the suspicion of malingering was aroused.

Audiometry, however, revealed the true state of affairs. The right ear gave a fairly typical conduction deafness curve. The left showed a curious graph giving at a frequency cycle of

512	a loss of	110	decibels
1,024	"	60	"
2,048	"	100	"
4,096	"	10	"

## Diseases of the Nose

Fracture of Nasal Bones .. .. .. ..	40
Fracture of Ethmoid .. .. .. ..	1
Eczema and furunculosis of Vestibule .. .. .. ..	19
Atrophic Rhinitis .. .. .. ..	12
Hypertrophic Rhinitis .. .. .. ..	165
Allergic and Vasomotor Rhinitis .. .. .. ..	33
Rhinitis Sicca .. .. .. ..	4
Deviations of the Septum .. .. .. ..	519
(of these 394 were resected)	
Perforation of the Septum .. .. .. ..	8
Epistaxis .. .. .. ..	100
Sinusitis Antrum .. .. .. ..	444
" Frontal .. .. .. ..	22
" Ethmoid .. .. .. ..	75
" Sphenoid .. .. .. ..	3
Exostosis .. .. .. ..	2
Papilloma .. .. .. ..	1
Epithelioma .. .. .. ..	2
Lupus .. .. .. ..	1
Gumma .. .. .. ..	1
Syphilitic Periostitis of Frontal Bone .. .. .. ..	1
Cavernous Sinus Thrombosis (furuncle) .. .. .. ..	1
Total	1,454

## Oto-Rhino-Laryngology in the Navy

Deviations of the nasal septum giving rise to symptoms were seen in 519 cases, and of these 394 underwent resection. In the opinion of some army surgeons, operations on the septum are a waste of time, and do not render a man any more fit for his duties. This is contrary to our experience. Naval personnel serving in submarines and in the Fleet Air Arm require special consideration. Deflections of the septum which, under normal conditions give rise to no symptoms, can cause sinus or Eustachian tube disorders when the subject is exposed to abnormal variations in pressure.

Pilots who do high altitude flying or dive bombing sometimes experience severe pain in the region of their frontal or maxillary sinuses. The mechanism of this "sinus barotrauma" or "aero-sinusitis" has been fully investigated by McGibbon (1944). He has shown that a flap of swollen mucosa or a polyp may act as a valve at the ostium of the affected sinus. During ascent, relatively increasing pressure in the sinus causes mucosal ischæmia. In descent, there is a relatively decreasing pressure of the sinus air content, which allows engorgement of the mucosal capillaries, with oedema, haemorrhage and effusion. There may be a difference between the pressure in the capillaries and that of the antral tissue fluid of 297.8 mm. of mercury.

The headache so produced may clear up on the ground, but can also persist for some hours. Treatment consists in the application of ephedrine to the swollen mucosa or by fracturing the middle turbinate medially. If the turbinate is partly or wholly hidden by a deflected septum, then resection is indicated.

When a deflection is associated with an obstructed Eustachian tube, operation may be required. It may, for instance, be necessary to provide a passage for the Eustachian catheter in a badly blocked nose. In any case, a free nasal airway on the affected side must be provided if a healthy and patent tube is to be maintained.

As in tonsillectomy cases, the administration of ascorbic acid (200 mgm. on the day previous to operation, and 25 mgm. daily thereafter until discharge) was found useful in the prevention of post-operative bleeding.

### SINUSITIS

Cases referred for treatment of nasal sinusitis numbered 544. Suppuration of the maxillary antrum was encountered in 444 patients, of whom 42 underwent intranasal antrostomy, and 91 the Caldwell-Luc operation.

The effect of injecting 5 c.c. of penicillin (1,000 units to the c.c.) into the antrum was tried in 41 cases with 18 cures and 23 failures. Of the latter, 10 eventually came to operation, and 3 were invalidated. Penicillin, therefore, was not found to be very effective in the conservative

## H. D. Brown Kelly

treatment of antral disease. The drug being in contact with the mucosa for only a short time before being expelled by ciliary action probably accounts for the disappointing results.

If the suppuration did not clear up with four to five lavages at three days interval, intranasal antrostomy was advised. In the case of disease of several year's standing, or if the discharge were foetid, the radical operation was preferred. Prolonged conservative treatment was impossible, as cases from distant bases had to be admitted to hospital and could not be treated as out-patients. An early return to duty also had to be aimed at.

In 21 cases of antral suppuration there was associated ethmoidal disease. The formation of choanal polypi was noted in 5 instances.

Cases of ethmoidal disease numbered 75, and of these 46 were associated with the formation of polypi. This high percentage suggests that the average naval rating does not seek relief from his sinusitis unless it is fairly far advanced and accompanied by a marked degree of obstruction.

These patients were treated by the removal of polypi with snare and punch forceps, and by the intranasal exenteration of diseased ethmoid cells.

Chronic ethmoiditis without polyp formation was dealt with by the Proetz method of ephedrine displacement with considerable success. No external operations were performed for uncomplicated ethmoidal disease. The prolonged stay in hospital was not justified in any of the cases encountered.

Sphenoidal suppuration was only seen in 3 cases. Pain behind the eyes and crusting in the nasopharynx and on the posterior pharyngeal wall were the main features. Considerable relief was obtained in these cases also by ephedrine displacement. (Proetz, 1939.)

### THE INVESTIGATION OF HEADACHE FROM THE RHINOLOGICAL ASPECT

Although a frequently encountered complaint, headache is often very difficult to assess. This is especially true of the Service, where the medical officer may find it hard to differentiate between cases due to organic or psychological causes and instances of malingering or exaggeration of symptoms.

Headache is a symptom, the presence or absence of which is impossible to prove. The patient's word must be accepted on this point. Head pains are therefore a favourite complaint of the man endeavouring to shirk his duties or to obtain his discharge from the Service.

The number of cases examined with regard to this symptom was 120. The majority of these had already undergone examination by a physician to exclude the more general causes of headache. No such cause having

## Oto-Rhino-Laryngology in the Navy

been found, they were referred for rhinological investigation, the presence of frontal sinusitis being usually suspected.

The most frequent cause of headaches of nasal origin is obstruction of sinus drainage. The fronto-nasal duct is easily blocked, usually the result of a cold on a nose already narrowed by a deviated septum or hypertrophied turbinates.

A useful means of separating those headaches due to obstructed sinus drainage from those due to other causes is the "ephedrine test". After the routine rhinological examination, the patient lies supine with the head hanging over the end of the couch so that the nostrils face the ceiling. The nose is then filled with 1 per cent. ephedrine in saline and the patient instructed to remain still, breathing through the mouth for at least five minutes. At the end of that time he sits up and blows the nose gently into a receiver so that the presence of pus in the fluid may be noted. If the headache is relieved by this procedure, it may be assumed that the trouble lies in the nose. If the pain remains unaltered, it is unlikely that the nose is at fault.

Response of the head pains to the ephedrine may be only temporary, but it is a useful indication that a nasal operation directed to improve sinus drainage will benefit the complaint.

### DIFFERENTIAL DIAGNOSIS BETWEEN HEADACHE DUE TO FRONTONASAL DUCT OBSTRUCTION, AND THAT DUE TO SPHENO-ETHMOIDAL DISEASE

The preliminary routine nasal examination having been carried out, an applicator bearing cotton wool soaked in 10 per cent. cocaine solution is inserted under the middle turbinate in the region of the fronto-nasal duct. This will shrink up the tissues in the vicinity of the duct outlet and relieve pain due to obstruction thereof.

Should the pain remain unaffected, the patient is given positional ephedrine treatment as described, which will now act on the posterior ethmoid cells and sphenoids, restoring ventilation and relieving pain.

Headache therefore, which is unaffected by the application of cocaine to the middle meatus, but which is relieved by the ephedrine therapy, is probably due to impaired drainage from the posterior group of sinuses.

### Diseases of the Throat

Pharynx.	Tonsillitis (tonsillectomies 601)	..	865
"	Infected Adenoids	.. ..	41
"	Chronic Pharyngitis	.. ..	17
			923

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Larynx.	Fracture (hyoid bone and thyroid cartilage)	1
"	Laryngitis .. .. .. ..	41
"	Tubercular laryngitis .. .. ..	18
"	Pachydermia laryngis .. .. ..	2
"	Papilloma .. .. .. ..	9
"	Fibroma .. .. .. ..	6
"	Epithelioma .. .. .. ..	2
"	Web of Glottis .. .. .. ..	3
"	Ventricular Dysphonia .. .. ..	1
"	Paralysis of Vocal Cord .. .. ..	9
"	Hysterical Aphonya .. .. .. ..	21
Œsophagus.	Carcinoma .. .. .. ..	2
Bronchi.	Carcinoma .. .. .. ..	2
		—
		117
		—

## TONSILLITIS

Patients with chronic tonsillitis admitted to the department numbered 804. Tonsillectomy was performed on 601 cases suffering from chronic or recurrent tonsillar infection. Reference may be made here to the ultra-conservative view concerning operations on Service personnel. Mitchiner (1944) writes—"Tonsillectomies and operations on the nasal septum undoubtedly constitute scalps for the operating surgeon, but how often do they make the patient any more fit for full duty in the rough and tumble of Service life?" It is not perhaps generally realized that the amount of Service time lost through tonsillitis is considerable. All cases operated upon in this hospital had suffered from more than one attack of tonsillitis, each necessitating an absence from duty of from one to three weeks. A rating with infected tonsils is a potential menace on a mess-deck where a certain degree of crowding is unavoidable and perfect ventilation difficult to obtain when battened down for rough weather.

The sailor is not the easiest subject on whom to operate. He is frequently difficult to anaesthetize. Repeated attacks of tonsillitis, sometimes accompanied by quinsy, render the tonsillar capsule very adherent, and hinder the retraction of blood vessels. Haemorrhage requires patience and care to control, and no case is allowed to leave the operating table unless the tonsillar beds are perfectly dry. All cases have their bleeding and coagulation rates taken before operation. The latter was often found to be excessively prolonged, being sometimes as much as 15 minutes instead of the usual 6 to 9 minutes.

A fact which impressed me after an absence of over a year from this country, was the increased tendency to bleed on the fourth or fifth day

## Oto-Rhino-Laryngology in the Navy

after tonsillectomy. Cases would leave the theatre quite dry, and remain so for several days, then there would be a sudden haemorrhage into one or both beds, in some instances necessitating a return to theatre and application of sutures.

From September 1939 to June 1943, 400 tonsillectomies were performed. Of these 6 bled after operation. From July 1943, to March 1944, 10 instances of secondary haemorrhage were noted in only 100 operations. This increase naturally gave rise to some concern. The possibility of there being some dietary vitamin deficiency responsible for delay in healing was considered. From April 1944 all operation cases were given ascorbic acid as routine (200 mgm. on the two days previous to operation, and 25 mgm. thereafter daily until discharge). From the inception of this routine until June 1945, 110 cases were operated upon, and of these 4 suffered from secondary haemorrhage. One had antral suppuration on the same side as the bleeding tonsil bed, so it is possible that infection here played a part.

Macbeth's (1943) experiences when operating on Service personnel in an E.M.S. hospital were similar. He found that both tonsillectomies and septal resections healed better and with a smaller percentage of complications if given ascorbic acid. It appears that after five years of war, no matter how excellently the rationing is managed, there is bound to be some vitamin deficiency. This is only slight, requiring an operation to make it clinically manifest.

I wish to thank the Medical Director-General of the Navy, and the Medical Officer in Charge, R.N. Aux. Hospital, Kingseat, for permission to publish this paper. My thanks are also due to Surgeon Commander J. B. Hutchison, R.N.V.R. for kindly allowing me to include records of his cases.

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## CLINICAL RECORD

### ETHMOIDAL EPISTAXIS NECESSITATING OPERATION —CASE REPORT

By J. L. D. WILLIAMS (Manchester)

THE following case of severe epistaxis is reported, as perhaps of some interest in view of the measures necessary to stop it.

On 2.9.43, Driver K., aged 23, was struck a glancing blow on the right side of the nose by a heavy tow-hook, which sprang back when the rope to which it was attached snapped. The skin was lacerated and he was dazed but not unconscious. Epistaxis was profuse for a few minutes, but it ceased spontaneously. He was admitted to a Camp Reception Station and later transferred to a Military General Hospital, where an X-ray showed a fracture of the nasal bones with slight backward displacement. There was an intermittent trickle of blood from the nose for three days, but this apparently gave rise to no anxiety and he was allowed up.

He was due for discharge from hospital on 9.9.43, but on the evening of the 8th, a profuse epistaxis occurred. The nose was plugged, morphia administered and he was returned to bed. No nasal bleeding was seen during the night, but the next morning he vomited a large quantity of old blood. When I saw him, for the first time, he was extremely pale, with a weak pulse of 140, and there was a considerable trickle of blood in the nasopharynx from the right side. The nasal plugging was removed, and a steady ooze was seen to be coming from the upper part of the right nasal cavity. Accurate location was impossible, but Kieselbach's area could be exonerated and it was thought that the middle meatus was probably the bleeding point. This area and the space between the middle turbinate and the septum were firmly packed with adrenalin gauze and bleeding was controlled. The next day (10.9.43) he was better and the pulse, although still rather weak, was 104. There had been no further nasal bleeding or vomiting, and removal of the nasal packing was commenced gradually. By afternoon this was completed, and was unaccompanied by recurrence of haemorrhage. However, during the night brisk bleeding recommenced, which was again arrested by packing, and a whole-blood transfusion was started. The result of the blood count is not available, but the only abnormality shown was a severe secondary anaemia.

The opinion of a neuro-surgeon, Major Calvert, was fortunately available, as a fracture of the ethmoid bone appeared to be probable. Major Calvert elicited a history of head injury in 1937, when the patient was hit on the right side of the head by a brick, an injury which was considered to be of no significance at that time. A doubtful bruit was also heard over the right orbit, and in view of the possibility of a cavernous arterio-venous aneurysm eroding the sphenoid and leaking into the nasopharynx, an arteriogram was considered

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advisable. By now, post-nasal bleeding had recommenced and was considerable, but on continuous drip transfusion of whole blood the patient's general condition had improved.

Under local anaesthesia, the internal and external carotids on the right side were exposed, and thorotrast injected into the internal. An arteriogram showed a normal carotid tree, and it was decided to tie the external carotid in an effort to diminish the blood supply to the right side of the nose. This procedure failed to alleviate the bleeding in any degree, and it was now as brisk as ever. Since the haemorrhage was therefore obviously ethmoidal in origin, the anterior and posterior ethmoidal vessels were exposed through the customary external ethmoid incision above the inner canthus. They were isolated without difficulty and appeared to be of normal calibre. There was no obvious fracture of the lamina papyracea, and the vessels were occluded by diathermy. This caused immediate cessation of the haemorrhage, and there was no subsequent recurrence. The patient made an uneventful recovery and was discharged from Hospital on 26.9.43. He received five pints of blood in all by drip transfusion. Examination of the nose and nasopharynx before he left hospital revealed no abnormality.

The literature at my disposal shows scant reference to ligation of the ethmoidal arteries for epistaxis, although it seems probable that this procedure must have been done often enough for an epistaxis occurring from the upper part of the nose failing to stop on simpler measures. It is a routine step in certain radical operations on the spheno-ethmoidal region. Goodyear quotes a case of intractable epistaxis, occurring nocturnally in a man of 74 with normal blood pressure. Malignancy was excluded and, under local anaesthesia, the ethmoidal vessels were tied by a similar approach to the one in the case reported here. The bleeding in Goodyear's case came from the medial wall of the middle turbinate, and the anterior ethmoidal artery was found to be abnormally large at operation. Bleeding stopped completely on ligation of the vessel.

This would appear to be a reasonable, safe and not too difficult procedure to adopt in a case of severe epistaxis from the upper part of the nose and not responding to less drastic means. In such a case, it is more logical to resort to dealing with the ethmoidal vessels before the internal maxillary or external carotid, as was done in the case reported here.

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## CLINICAL NOTE

### GUN BLAST AND THE USE OF MOULDED EAR DEFENDERS

By J. ANGELL JAMES (Bristol), LT.-COL., R.A.M.C.

THE development of high muzzle velocity guns fitted with muzzle brakes has increased considerably the aural trauma to which gunners are exposed.

Gun blast affects both middle and inner ear. The effects of the blast on the middle ear may range from simple engorgement of the vessels along the handle of the malleus and Shrapnell's membrane, to vesiculation, haemorrhages, haemorrhages into middle ear, perforations and even to complete loss of the tympanic membrane, leaving the handle of the malleus hanging free. The effect on the inner ear is to produce a perception deafness, often associated with tinnitus, and very occasionally a transitory vertigo. The effects produced by any given gun have been found to vary under different conditions and in different individuals. There is no constant ratio between the severity of the damage in the middle and that in the inner ear. The cases fall into two groups :

1. The first group consists of those who have been injured by an exceptionally severe blast. Significant middle-ear damage is found only in this group, and the lesions are similar to those caused by mine, bomb or shell burst. The audiogram shows abrupt high tone loss.
2. The second group consists of gunners who have been engaged in firing for long periods. The engorgement of the tympanic membrane seen in this group immediately after firing is transient. The deafness resembles the perception deafness from prolonged exposure to the noise of machinery. The audiogram shows gradual high tone loss.

The factors that predispose to blast injury are mainly mechanical, and concern the type and siting of the gun, and the position of the gunners ; but certain characteristics in the gunners also play a part.

The muzzle velocity determines the magnitude of the blast wave, but a muzzle brake throws the blast backwards towards the gunners. Siting the gun in a hollow or ravine, or against or between walls, increases the blast, by interfering with the free escape of the gases. Firing into the wind with the muzzle depressed throws the blast backwards. A more severe blast is received when the muzzle is depressed, than when it is elevated. A gunner, who is standing a few feet laterally from the breach of the gun, will suffer more than one beside the breach. A turret provides some protection. The effect is likely to be more severe if the gunner is not prepared for the shot. A novice is usually affected more than an experienced man, but the relative immunity of the latter may be reduced or lost if he is unfit, or has spent some months away from the guns. The importance of position and preparedness has been stressed, on account of the number of experienced gunners, who have been

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seen with serious blast trauma due to the firing of a single shot unexpectedly, or when they are unusually near the muzzle of the gun.

Pre-existing ear diseases or injury, which have left either perception deafness or middle-ear damage, may render the ear more susceptible to blast. Patients with such lesions may complain of pain in the ears on firing. A few patients have been seen, whose quiescent suppurative otitis media or externa has been reactivated apparently by firing. The shape and diameter of the meatus, within normal limits, and the presence or absence of moderate amounts of cerumen, have no demonstrable significance. Unless there is severe nasal obstruction, there seems to be very little advantage gained by opening the mouth, with the idea that the pressure on the two sides of the tympanic membrane will be equalized, by the simultaneous effect through the Eustachian tube and external auditory meatus.

Deafness usually lasts from a few minutes to three hours, depending on the severity of the blast, and the length of time of exposure; but a number of individuals notice some deafness for 24 hours, and the more susceptible for three to four days. Recovery is gradual, and after 2 months any residual deafness is likely to be permanent; although gradual improvement in hearing has been noted in one or two patients over periods up to 8 months. In a very few cases there is progressive deterioration for some months after the blast injury.

In the latter half of 1943 and the early months of 1944, the opportunity occurred of examining gunners working on high muzzle velocity guns during practice, and later in action. The consideration of the results of these examinations, and of the histories given by, and lesions shown by gun-deafened patients, led to the conclusion that some form of ear defender was necessary, but that none of those available at the time was entirely satisfactory for every individual. A number of patients have been seen who had been deafened, and in some cases suffered rupture of the tympanic membrane also from gunfire, in spite of having worn cotton wool or rubber defenders during the firing. Other patients, who were complaining of severe pain in the ears on firing, as the result of a previous blast injury, found that cotton wool or rubber defenders would not prevent it. Suggit (1) and Taylor (2) also consider that cotton wool does not provide full protection; and the latter refers to moulded and soft rubber defenders as being more efficient.

The ideal defender should protect the middle and inner ear from blast and excessive noise, but should not interfere unduly with the hearing of orders given directly by mouth, or, through head phones or loud-speakers. It should be light, unbreakable, comfortable and non-irritating to the skin, and should be easily applied and removed, cleaned and sterilized.

At the time when the experiments were made, approximately 10 per cent. of the gunners were found to be using ear defenders. The majority preferred cotton wool, but a few had rubber, and one or two used paper, none were using plasticine. Of those who did not use defenders, a number thought they could not hear orders while wearing them, while the remainder complained that they were uncomfortable, or fell out of their ears, or that they could not be bothered with them. A number of the last group admitted that they mitigated the effect of the blast by:

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1. Turning the face towards the gun, so that the blast wave would not enter either external auditory meatus in a direct line from the muzzle.
2. Turning the back to the gun, or bending the head, so that ears were protected by the brim of the helmet.
3. Closing one meatus with a finger and turning that side to the gun, or closing both meatus if both hands were free.

With very few exceptions, all the gunners who had worked on the guns for six months or more showed some reduction in hearing acuity, particularly for pitches above 2048 D.V.s. No audiometer was available, and the tests used were made by voice, watch and tuning forks. The degree of deafness was found to be roughly proportional to the length of service as a gunner, but individual variations were considerable. The gunners were examined before and after firing, with and without ear defenders. The majority of those acting as numbers 1, 2, or 3 of the gun detachment showed vascular engorgement of the drum and some reduction of hearing acuity after firing without defenders. Rubber, and to a lesser extent cotton wool plugs, reduced but did not entirely abolish, these changes. In no case did they prevent the hearing of orders. It was apparent, that neither cotton wool, nor the standard rubber cone ear plug, provided complete protection.

A trial was then made with moulded plugs filling the cartilaginous portion of the meatus and cavum conchae. They were designed with the idea that they would seat down and seal off the meatus under the pressure of the blast wave. It was intended to bore them to allow orders to be heard clearly, but it was found that the slight looseness of fit due to movements of the condyle of the mandible enabled orders to be heard clearly. Impressions of the meatus and concha were taken on each side using plaster of Paris or dental wax, after inserting a wool plug into the deep meatus and lubricating the area with vaseline. From the impression vulcanite, and later acrylic defenders, were made. These defenders, which have a flat outer surface, and a wire loop for use as a handle, are inserted with a quarter circle turn in a clockwise direction for the left ear, anti-clockwise for the right ear. They are removed by a reverse movement. It is important that they should not penetrate deeper than half an inch into the meatus, as they may be uncomfortable if they are longer. They can be washed and sterilized.

A person with normal hearing is able to hear a whisper at fifteen to twenty feet when wearing them. Unfortunately no large scale experiments have been possible, but in cases where these defenders have been used, observation has not revealed any engorgement of the drum and hearing loss has been minimal. They have proved of particular value for gunners who have developed hypersensitivity to gun blast as a result of previous blast injury, and in whom cotton wool or rubber plugs have proved ineffective in preventing the pain caused by gunfire. The mechanism of causation of this unusual condition is obscure, but it is always associated with a blast induced perception deafness, with or without permanent middle-ear damage. It has been suggested by Collins (3) that it is due to rupture of the tensor tympani or stapedius muscle.

In spite of the labour involved in making moulded acrylic defenders, the protection they provide is worth the trouble for patients suffering from blast



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hypersensitiveness, and for men serving as numbers 1, 2, or 3 in their gun detachments, or others whose ears are unusually sensitive to noise and blast.

The advantages claimed for moulded acrylic defenders compared with those of cotton wool or rubber are:

1. They provide better protection.
2. They are more hygienic.

The disadvantages are:

1. The labour involved in making them.
2. It requires an intelligent person to keep them clean, and to insert and remove them without injury to the meatal skin. (No case of otitis externa caused by these defenders has been seen. One case of chronic otitis externa recovered when acrylic defenders were used instead of wool.)

I am indebted to Captain H. F. Atkinson, A.D. Corps for the following notes on the making of acrylic defenders:

"The impressions for ear plugs are received with the excess wax forming a small handle on which the letters 'L' or 'R' have been marked. As the plugs are very easily distorted whilst trimming, it is advisable to work over a bowl of ice-cold water and frequently immerse them in it. So that the plugs will not be reversed only one is trimmed up at a time; the excess wax is cut off, the external surface smoothed over and the edges rounded, then a bold 'L' or 'R' is carved in the flat external surface. For ease of recognition this letter should fill the whole of the external area. A twisted loop one quarter of an inch in diameter, of 25 S.W.G. stainless steel wire is then thrust into the external surface, the whole is then processed in acrylic as for a denture. The finished plug is lightly polished over the whole surface. A raised indicating letter can be produced on the external surface by carving on the plaster after flasking.

The main points to observe in the making of the plugs are:

1. Not to distort or mix up the wax impressions while trimming up.
2. To mark the finished plug clearly and boldly.
3. To have a smoothed polished impression surface.
4. Wire loops large enough for easy handling."

My thanks are due to Colonel G. Garraway for permission to submit this paper and to Captain E. Williams, A.D. Corps and Captain A. Cooke, A.D. Corps for their advice and help in the preparation of the defenders.

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## SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOTOLOGY

March 2nd, 1945

*President—L. GRAHAM-BROWN, F.R.C.S.*

### Discussion on Masking Effects of Sulphonamide when used in the Treatment of Acute Otitis Media\*

MR. G. EWART MARTIN said he had listened to this paper with great interest. In May, 1944, Mr. Stirk Adams and he read papers to the Section on treatment with sulphonamides. He recorded from cases attending the Ear, Nose and Throat Out-patient Department in the Royal Infirmary, Edinburgh, under his charge the number of mastoid and intracranial complications following on otitis media, as shown by the records. This table has been exhibited by Dr. Farquharson to-day with additions. The numbers of out-patients attending the Ear, Nose and Throat Department had almost doubled and yet the number of acute ear cases almost halved, while the number of complications had remained about the same.

We were struck by the very marked increase of deafness in the cases we were able to follow up. The usual type of case which we were seeing was one who had reported to their own doctor with acute pain in the ear, had been given a box of pills to take, sometimes with very minute instructions as how to take them. The pain had disappeared, there was no temperature but the patient complained of increasing deafness and was sent up to us with the complaint of deafness possibly 3 to 4 weeks after the original acute ear. Amongst these cases there was a large proportion of mastoid infection. Some of the cases we had paracentesed but only in a very small majority were we able to improve the hearing to any great extent.

Quite a different story is told by a survey of his own private cases where the patient is seen early, kept under observation, very seldom given any of the sulpha drugs, in fact in 1941 he could only find two cases of deafness persisting after an acute ear and four in 1943.

With proper care we have in the sulpha group a drug which has done more to help us in the cure of ear infection than anything in the past. It has given us a means of treating meningitis and reduced a 100 per cent. fatality in this disease to a 50 per cent. Penicillin is going to help us still further in the treatment of intracranial complications and one hopes it will not be used indiscriminately, because, if it is interfering with function it would be better to go back to the pre-sulpha days.

WING COMMANDER G. H. BETEMAN said that he must strike a discordant note. It was assumed that the use of sulphonamides in acute otitis media was desirable and did decrease the number of mastoid operations. The only query seemed to be as to the right way to use them. The figures which had been produced that day and at other times might be misleading. It might not be

\* Opening Paper by Dr. Malcolm Farquharson on pp. 269-278.

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the sulphonamides which produced the number of mastoid operations, perhaps their criteria for operations had changed. It might be that now that they had sulphonamides they were prepared to wait longer before deciding to operate, and the patient got well—as many patients would anyway—before the time came for the operation to be performed. Again, a comparison of one group of years with another might mislead, because diseases did change their character in the course of years. Scarlet fever a number of years ago was a very different disease from what it was to-day.

He had examined case histories in the R.A.F. and had produced a series of figures which suggested that sulphonamides during that period had increased the number of mastoid operations done. In two groups of patients, one treated with sulphonamides and the other not, the patients with sulphonamides had more mastoid operations than the other group, but the statistician to whom he showed the figures said that they were not valid. He had no doubt the statistician was right, but the same criticism could be brought against the figures which had been produced in that discussion, and those brought forward by Mr. Stirk Adams last year. Mr. Ewart Martin had suggested that sulphonamides had decreased the number of mastoid operations necessary. His own feeling was that acute otitis media was not beneficially influenced by the exhibition of sulphonamides. Having sulphonamides in the background led them to adopt expectant treatment for longer than before sulphonamides were available, and therefore it was made to appear that the results were better. In his view sulphonamides were not indicated in the treatment of acute otitis media.

MR. A. R. DINGLEY agreed with Wing Commander Bateman concerning the dangers of sulphonamides in middle-ear suppuration. He thought the Edinburgh figures could be misleading.

If there were a lesser number of mastoid operations nowadays, it might be due to the fact that practically all otologists open the mastoid much later than they did 15-20 years ago, and many cases operated on in those days would have escaped operation altogether if left to themselves.

Undoubtedly, sulphonamides given in the acute nasopharyngeal infection, before the ear is involved, must prevent the onset of many cases of otitis.

The emphasis on injury to hearing was important. Deafness could follow the use of these drugs; the tendency to anchor the middle ear exudate behind a sodden drum, and to make it more sticky, may explain this. If the ear drum was opened early, these cases of deafness would not occur.

He thought that if a case had been treated with sulphonamide, and the ear apparently, had recovered, the signs for which to look in cases of doubt would be, particularly in children, pallor, slight rise of evening temperature, loss of weight, headache and deafness.

Examination of the drumhead shows a bulging oedematous membrane, and an extensive and dangerous involvement of the mastoid may be present and have been masked.

AIR COMMODORE E. D. D. DICKSON quoted a case of typical masking he had seen the previous week. A W.A.A.F. admitted to the infectious diseases block with acute nasopharyngitis, developed acute otitis media. This necessitated a myringotomy on the right side on 9.1.45 and four days later on

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the left ear. Sulphonamide therapy was started on 13.1.45 and by 17.1.45 the left tympanic membrane had healed. It was stopped on 19.1.45 after a dosage of 31 grams. By 21.1.45 the hearing in the left ear was normal but the right tympanic membrane although healed remained injected and hearing was poor. When seen four weeks later deafness persisted (whispered voice 4 feet) temperature was normal, but there was tenderness on forceful pressure over the right mastoid antrum and tip. Mastoidectomy performed the next day. Frank pus found in the antrum and in the cells around it and in the tip. A chain of necrotic cells was present along the facial area, lateral sinus and middle fossa dura.

It may interest Dr. Farquharson to know that in the R.A.F. cases of acute otitis media are admitted to hospital as early as possible and medical officers are advised to withhold sulphonamides until admission. The case is thus under observation by the otologist from the moment chemotherapy is started.

MR. TERENCE CAWTHORNE said that such a discussion could only be satisfactorily concluded if a series of cases were treated without sulphonamides and a corresponding series treated with sulphonamides. But to do this was rather to forget the patient. Another aspect of treatment with sulphonamides was that the patient, after having one or two doses (this might not apply to the latest type of preparation), found that he felt rather sick and so refused to go on with it.

MR. OWEN said that early hospitalization of these cases was really impossible unless otitis media became a notifiable disease.

He would like a definite statement from Mr. Farquharson as to when sulphonamides ought to be used. If he were to see these cases of otitis media in the early stages, say in the first 24 hours, when nasopharyngitis was active, would he use sulphonamides? Were the practitioners to continue with this or not? A statement ought to be made in this section to-day and a ruling given as to what their advice to the practitioner should be, instead of leaving him in mid-air.

MR. C. P. WILSON said that this problem was becoming one of national importance, and from the economic point of view alone it was a very serious problem at the moment. Every speaker had said more or less the same thing in a slightly different way. He himself was operating on far more mastoids than he had ever done in his life before, thanks, in his view, partly to sulphonamides. A committee had been set up by the Royal Society of Medicine to investigate the effect of oestrogens in carcinoma, because a similar situation had arisen in the treatment of carcinoma with stilboestrol and preparations of that nature. He echoed what Mr. Owen had said about the need for an authoritative statement in the matter under discussion at present, but he felt that this could best be obtained by forming a small committee of investigation which could decide on certain problems with a view to the correlation of treatment. Such a body might take six months or a year in coming to their conclusions, and then they might be prepared to come to that Society with quite definite recommendations which would have some air of authority. They had all seen correspondence in the medical press—he remembered one such correspondence initiated by Mr. Dingley—and the most diverse statements had been made. This confusion would continue unless some authoritative

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guidance was afforded. Otherwise they might do more harm than good by making dogmatic statements.

MR. THACKER NEVILLE, concerning the question of masking, recalled a case of a frightened child evacuee, who had a temperature of 99·6, with pain in the right ear, and had been treated for influenza with sulphadiazine. When he came to examine the ears he found hard wax in both. He suggested oil locally and after 24 hours he gave ethyl chloride and removed the wax from the painful ear. The tympanic membrane was not red, yet within 24 hours the ear was full of pulsating pus, thus sulphadiazine had prevented the usual tympanic injection. As regards deafness, when he did a paracentesis the patients were slightly deaf afterwards and so he always had to pass a catheter or prescribe a Fowler's auto-insufflator. The family doctors in his area treated the children with sulphadiazine, and therefore he himself did not see them, and their ears were never inflated after the inflammation had subsided. Was not the want of inflation partly the cause of the deafness?

MR. CAWTHORNE mentioned, in connection with what Mr. Wilson had just said, that there was a committee of the Medical Research Council which was investigating ear disease.

MR. FORSTER referred to Mr. Farquharson's remark about the comparative insolubility of sulphadiazine, and he had seen recently one case of haematuria with the passing of crystals in the urine, a reminder of the importance of a high fluid intake and the use of an alkaline citrate mixture. On the other hand his short experience of the use of this drug in their specialty had been favourable, and without the nauseating symptoms associated with the taking of some of its allied compounds.

MR. RITCHIE RODGER asked whether the difficulty was not due to the fact that by the time they saw the patient, or even by the time the general practitioner saw the patient, the problem was generally a physical one as well as a chemical one, and chemotherapy was of no use for the physical part of the problem. The first symptom that brought the patient to the doctor has earache, and earache was nearly always due to tension of pus or seropus. When these new drugs were given the symptoms were suppressed but the physical part of the problem was not dealt with, the result being deafness from an adhesive process in the middle ear. In the same way serous effusion in the mastoid antrum or cells was left unrelieved. Particularly should attention be given to the education of general practitioners, explaining to them that the reason why the middle ear did not respond to these drugs as the lungs or the meninges responded was that in the ear there was not the efficient drainage which nature had provided for serum in the brain and in the lung.

MAJOR HOOPLE, U.S.A.M.C., mentioned that he had had a case of mastoiditis treated by penicillin which had gone on to brain abscess. This again seemed to be an example of masking.

THE PRESIDENT said that they had all known examples of these cases in which masking had occurred, and they could come to the conclusion that sulphonamide, when administered perhaps unwisely, did lead to a lot of trouble. He thought the trouble lay in the fact that in hospital practice, or even in private practice, they saw very few cases of acute otorrhoea which came to them early enough to allow them to say that they would treat the case with

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sulphonamide. The disasters he had seen had given him rather an aversion to the use of sulphonamides, although he did recognize their value, particularly in the complications. He would say that sulphonamides should be used, in adequate dosage, early in the case of otitis media, but should never be used after that until the diagnosis was assured. If pus was present, the appropriate surgical measure should be carried out, extending right down to the meninges. Then the use of sulphonamides would be valuable. He thought that penicillin would probably replace them to a great extent when it was available for civilian patients.

As regards the education of the general practitioner, it was a very difficult thing for anybody to dictate to him. Matters were easier, probably, in a military hospital, where the otologist could pass round the word to the regimental medical officers concerning the treatment of every acute case with sulphonamides or not. Thus some statistics of value would be obtained which might lead to the avoidance of the masking symptoms.

MR. FARQUHARSON, in reply, said that he agreed with what other speakers had said concerning the inadequate dosage of the drug. Even with adequate dosage this masking effect might still exist, and in one or two of his cases he had shown this to be so. The opinion of the present meeting had been against the promiscuous use of the drug in every case.

Wing Commander Bateman had spoken of mastoid operations becoming more frequent since the use of the drug. That might be relatively so, but taking the average from their records, the numbers was still less than previously. Wing Commander Bateman also mentioned that, like scarlet fever, otitis media had diminished in severity during the last few years. He thought, however, that the figures which he himself had given in his papers were too close together to support any parallel with that—that is to say, the periods were 1932 to 1936 and then 1936 to 1944. There was a very definite reduction after 1936.

Mr. Dingley had mentioned the increasing incidence of deafness after use of the drug. Instead of the patient being sent up to hospital for an early paracentesis he had the drug administered by his own doctor, and it was only when deafness occurred that the otologist saw the case.

Mr. Cawthorne had remarked that there should be more careful control. That might give a better view of the drug's action. Mr. Owen had asked for a definite statement as to whether sulphonamide should be given by the patient's doctor? He thought that the answer was that the drug should not be so given; in virulent infections the decision as to whether sulphonamides should be given or not should be left in the hands of the Otologist.

Mr. Cawthorne had answered Mr. Wilson's question about a special committee. In answer to Mr. Thacker Neville, he must say that he did not think that deafness was altogether due to lack of inflation. Major Hoople had mentioned the question of masking by Penicillin, and he thought it was conceivable that such masking might occur because the masking in otitis media was very largely due to the drugs not reaching the mastoid owing to thrombosis of the vessels, and this could occur with penicillin as much as with sulphonamide. He would say that the same risks were run with penicillin as with the sulphonamides for that reason.

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## THE TREATMENT OF CHRONIC OTITIS MEDIA

By COLIN M. JOHNSTON (London)

IT may seem unnecessary to begin this paper with a self-evident observation, but I feel strongly that the successful treatment of chronic suppuration of the middle ear depends on a correct appreciation of the causes. I propose to mention briefly the commoner etiological factors.

How often does one not, in the course of examination of a patient who may have had treatment for several weeks, find the external meatus coated with a thick layer of dried pus and debris, sometimes with a mild otitis externa. This forms a good culture medium for organisms, particularly the staphylococcus. Careful, regular, and if necessary, daily removal of this layer will often be all that is necessary to cause the ear to dry up. Although in most cases other factors are also concerned in keeping the suppuration active, there are nevertheless a considerable proportion of what one might term the "dirt chronic ear".

The position of the perforation in the ear drum, as is generally recognized, will often give useful information. One's search for the cause is directed as it were beyond the site of the perforation, thus the anterior position leads to the Eustachian tube and nose, while the postero-superior position leads to the aditus and mastoid antrum. As a corollary I do not usually expect to find, say an infection of the maxillary antrum with a posterior perforation or a mastoid infection with an anterior perforation, but exceptions commonly occur. I am doubtful if a pin hole perforation is usually the cause of poor drainage necessitating a paracentesis and prefer to look elsewhere before incising the drum.

Granulation tissue may merely be an attempt at healing of superficial ulceration in the presence of infection or may indicate underlying bone disease. In either case, this tissue is infected. Frequently this infection is the sole cause of the chronic suppuration and in the former case removal

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of the granulations will cure the otorrhea. When there is osteitis the granulation tissue will persistently recur but repeated removal may minimize the infection and enable limitation of necrosis and absorption of dead bone to occur. Unfortunately in many cases this limitation will not take place and the disease spreads to more vital areas.

Cholesteatoma may be visible or its presence suspected, from an offensive discharge persisting despite thorough treatment, but the occasional case will present itself with little beyond an intermittent and slight offensive discharge—a trap for the unwary.

Fibrosis of the Eustachian cushion, mucosal hyperplasia of the tube or pressure by growth will interfere with the ciliary activity and functioning of this part. In many instances the cause will be in the nose or pharynx and if discovered and treated early enough will prevent irreparable damage. The converse condition of excessive patency can be postulated in the patient with a frothy discharge from an anterior perforation, and where investigation of the nose, sinuses and pharynx fails to reveal an abnormality when judged by the usual criteria, I can only conclude that the active factor in maintaining the discharge is in the Eustachian tube.

The prevention of ascending infection to the ear is dependent on a healthy nose or nasopharynx, and Proetz has shown the importance of ciliary activity in resistance to nasal infection. Septal deviation or abnormalities of the turbinals, particularly the middle turbinal, may cause local drying of the mucus blanket with slowing of ciliary movement. It is to me rather surprising that otitis media is not more common than it is with atrophic rhinitis. If infection is absent, allergic or vasomotor rhinitis and allergic sinusitis does not appear to have a significant connection with otitis media. Infection of the sinuses is a common cause of chronicity of otitis media and I do not consider that one can hope to obtain a permanent cure of the ear unless the sinuses, particularly the maxillary sinus, have been cleared of infection. It is my impression that over half the patients with an anterior perforation have pus in the maxillary sinus, often on the same side. In this connection I would like to stress the fact that anterior and posterior rhinoscopy and trans-illumination will often fail to reveal any abnormality. A good radiograph may be the only positive finding apart from proof puncture returning pus. I consider that in such cases, if the antral washout is clean, an opacity in the radiograph indicating thickening of the mucosa due to allergy or subsiding infection, can be disregarded. Chronic otitis media due to a solitary infection of the ethmoid is less common and of the sphenoids rare. I have never seen an otitis media with an infection confined to the frontal sinus. In children enlarged adenoids will cause an ascending tubal infection, and if in their removal the curette exposes the muscle fibres of the superior constrictor, excessive scarring will

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prevent regeneration of ciliated mucosa and give rise to a chronic nasopharyngitis. I have not found chronic infection of the tonsils a likely factor ; at least in the few cases seen where the tonsils were removed for this purpose, the otorrhœa was not cured, but attacks of acute tonsillitis may light up infection in a quiescent ear.

Poor general health, exposure to the elements and bad housing conditions undoubtedly aid the other factors in keeping the infection active and partly explains the good results obtained with hospitalization and the frequency with which such ears tend to relapse under conditions of active service. The possibility of tuberculous infection should not be forgotten.

The most essential part of the conservative treatment of a suppurating ear is the removal of pus and debris from the meatus at frequent intervals. The ideal is attained when the meatus is mopped out by the surgeon or a skilled nurse, using a speculum and head mirror, particular attention being paid to the anterior part of the drum where the acute angle between the meatal wall and drum makes removal of epithelial scales difficult. It is important not to cause pain as the treatment may be prolonged, but fortunately most cases with a long-standing discharge seem to have a much reduced sensitivity to touch of the meatus and drum. I find that a fine light-weight probe such as the Jobson Horne, on which a small wisp of cotton wool can be mounted, will rapidly remove the last traces of debris, particularly if a boring or rotatory movement is employed.

As a useful adjuvant, aspiration of the pus through a No. 1 Eustachian catheter with a suction pump will save much time. It is an ideal method of removing cholesteatoma from the middle ear. Many patients find the hissing noise unpleasant and pain will be caused if the end of the catheter is accidentally applied to the drum.

When there is a shortage of skilled staff, syringing is a good substitute for dry mopping and gives good results in most cases except where there is a scanty discharge from a large central perforation.

Polypi and granulation tissue should be treated at the earliest opportunity. Unless the base of the polyp can be seen, removal by a cutting snare is preferred as traction may open the labyrinth or damage the facial nerve. For smaller polypi or exuberant granulations, fused chromic acid on a fine probe penetrates deeply and will often cause the whole mass to shrivel up ; for this reason it should not be used over the labyrinth or facial nerve. For a less penetrating effect, trichloracetic acid is applied as a saturated solution on a minute piece of cotton wool held on a fine probe and can be accurately placed on the granulation tissue.

Syringing the middle ear with spirit through an attic cannula placed in the perforation may remove debris and if followed by aspiration the shrinkage caused by dehydration will often allow of the removal of

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cholesteatomatous masses. An effective attic cannula can be made by grinding the point off an intravenous needle about one and three-quarter inches long.

Although nearly always tried in the resistant case, I have not found zinc ionization to be of much value.

The choice of medicament to be inserted into the ear after cleansing lies between a powder or liquid. If, in the absence of cholesteatoma, there is a little mucosal swelling in the middle ear and a large perforation allowing free drainage, a thin dusting of powder will reduce the secondary infection from the meatus by its antiseptic action and absorption of moisture. I have found that a profuse discharge rapidly washes away the powder and does not usually give such good results, and therefore confine its use to cases where the discharge is sufficiently scanty for one to be able to see traces of powder remaining at the next treatment. Boracic and iodine may be irritating in some cases. I find sulphanilamide powder satisfactory. Sulphathiazole has caused considerable irritation with some ears. Good results have been obtained by mopping the meatus with acetone followed by a light dusting with sulphanilamide powder. When the drainage from the middle ear is affected by mucosal swelling or a small perforation, and also in cases of cholesteatoma, spirit drops have given satisfaction. If the perforation is small, as in the attic region, good results have been obtained by causing the drops to enter the middle ear by a replacement technique, using a Siegle's speculum and air bulb. 10% protargol in a 50% spirit and water solution occasionally give good results where the middle ear mucosa is oedematous or engorged.

A lightly packed cotton wool plug in the meatus is used to prevent the entrance of air borne organisms and absorb the discharge. There is a great tendency for nurses and patients alike to pack too much wool deeply into the meatus so that it acts as a cork, damming up secretion.

These opinions are based on my experience as whole time assistant at Horton Emergency Hospital in the last four and a half years where there have been up to 180 beds available for ear, nose and throat cases in service personnel and civilians. In addition I have seen an average of 2,000 patients a year in the out-patient clinic. The advantages of in-patient over out-patient treatment have been obvious, both in the time taken to cure aural discharge and in the successful results obtained where out-patient treatment had failed.

I would like to take this opportunity of expressing my thanks to Mr. Negus, Mr. Cawthorne and Mr. Hogg for their help and advice at all times and for giving me the knowledge on which these comments are based.

## THE TREATMENT OF CHRONIC OTITIS MEDIA

By T. M. BANHAM, SQUADRON-LEADER, R.A.F.V.R.

NEARLY 20 per cent. of some 3,500 new out-patients attending a Royal Air Force Ear, Nose and Throat Clinic during 1943 and 1944, were found to have active chronic otitis media. An equal number were found to have symptoms resulting from past middle-ear infection. Some 40 per cent. of all the cases attending the clinic had, therefore, symptoms of active or inactive middle-ear infection. Apparently a similar percentage of these cases is found in the other services. Major Craig reported that 25 per cent. of his cases at a military hospital were found to have chronic middle-ear suppuration (1941 *J. R.A.M.C.* lxxvi, p. 86). It is seen, therefore, that the treatment of chronic middle-ear disease occupies a large part of the service otologist's time.

The Royal Air Force Consultant in Oto-laryngology—Air Commodore Dickson—has found that service personnel, upon whom the usual operative treatment of radical or modified radical mastoidectomy has been performed, are in most cases unfit for further active service. As a general rule, therefore, cases of chronic otitis media are treated by conservative methods in the Royal Air Force. Those that do not respond satisfactorily are invalidated unless they are valuable trained personnel or operative treatment is considered to be urgently required.

The conservative method of treatment used at one Royal Air Force clinic is described and the results that may be expected are illustrated by the report of a series of treated cases. The clinic is in a Royal Air Force Hospital on a large Station. Several flying and technical stations are within a few miles and the communications to the hospital are extremely good. The situation of such a service clinic is important, if prolonged out-patient treatment is being undertaken. Patients from the parent or neighbouring stations can be treated with little or no loss of working time. Cases from more distant units can be attached to one of these stations and fully employed in their trade whilst they are attending for treatment. If more intensive treatment is necessary they are admitted to hospital.

The details of the conservative method of treatment are as follows:

The ear is thoroughly cleaned, under direct vision, using wisps of cotton wool wound on to a Jobson Horne wool carrier. Any aural polypi or granulations, which are revealed by cleansing, are treated at the first attendance. Small polypi are removed with crocodile aural forceps, after

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anæsthetizing the ear with cocaine 5 per cent., to which a few drops of adrenalin have been added. This solution is applied on sterile cotton wool which is packed into the depths of the meatus for about 10 minutes. The polyp is then seized with the forceps, under direct vision and pulled out very gently. *Large polypi* are removed with a snare under general anaesthesia. The base of the polyp and any flat granulations are cauterized with trichloracetic acid. The middle ear is now emptied by inflating the Eustachian tube. In the great majority of cases this can be done by Valsalva's method. If the Eustachian tube is obstructed the middle ear is best emptied by suction applied through a fine cannula passed through the perforation. The ear is swabbed out with ether methylated solution to remove all discharge and debris from the accessible part of the middle ear and the depths of the meatus. Powder is now insufflated so as to enter the middle ear. A ribbon gauze wick is passed down to the tympanic membrane and loosely packed into the meatus to promote drainage of the discharge away from the middle ear. This treatment is repeated as frequently as is required, the gauze wick being removed as soon as it is soaked through to the outside. This may mean treatment once or twice a day, every two or three days, or once a week. The patient is instructed to remove the gauze wick as soon as it has soaked through or in any case after 24 hours. During the course of treatment any nasopharyngeal source of infection must be eradicated.

I have used several different powders. The most suitable seem to be boracic with 1 per cent. iodine and boracic with sulphathiazole in equal parts.

Sulphapyridine I never use undiluted, owing to its tendency to cake into a hard mass, which is often difficult to remove from the meatus. The chief objection to a powder containing sulphathiazole seems to be that a few patients develop an external otitis from sensitivity to the drug.

I am sure that the most important part of this treatment is the thorough cleaning of the depths of the meatus and middle ear under direct vision. I feel that it is important that this should be done by the otologist himself unless he has a nursing staff especially trained in end-aural manipulations. If, for any reason, personal attention cannot be given syringing is considered to be the surest and safest method of cleansing the meatus. Blind cleaning by the patient or untrained personnel is never allowed.

To try and assess the value of this type of treatment a series of 200 unselected patients were treated. (Of course, all these patients have previously been examined by National Service Medical Boards and some of the grosser cases of chronic otitis media have been eliminated.) All cases were treated, even when it was felt at the outset that operation would be required, the conservative treatment was attempted and persisted

# The Treatment of Chronic Otitis Media

with for at least six months. The only cases where treatment was discontinued was if the aural discharge remained offensive after several days treatment. This is a sure sign that bone necrosis is taking place. The foul smell of a gauze wick removed from the meatus of a patient with enclosed cholesteatoma is quite characteristic. In these cases operative treatment is undertaken without further delay.

A satisfactory end result of treatment is a dry ear. This means that not only does the patient report that there is no discharge but, on examination, the middle ear is seen to be free from discharge or granulation tissue.

It must be emphasized that this result is certainly not a cure. Any patient with an open perforation of the tympanic membrane is liable to a recurrence of otorrhœa if a nasopharyngeal infection is contracted, or moisture is allowed to enter the middle ear.

In considering the results of treatment of this series of cases it must be remembered that all these patients are adults who are well housed and fed, their medical attention is free and there is no loss of wages whilst they attend for treatment.

The 200 cases of chronic middle-ear discharge have been grouped according to their otoscopic appearances.

A *central perforation* has been taken to mean one affecting the

TABLE I  
200 CASES CLASSIFIED ACCORDING TO THE OTOSCOPIC APPEARANCE.  
RESULTS OF CONSERVATIVE TREATMENT

Site of Perforation.	Total in Series.	Number with Dry Ear after Treatment.
Central Perforation	133 (67% of Whole Series)	124 (93%)
Attic Perforation	23 (12% of Whole Series)	19 (82%)
Marginal Perforation	41 (20% of Whole Series)	20 (49%)
Site of Perforation not Identified	3	2

Of the 165 patients with dry ears

80 (49%) had *Improved Hearing* in the affected ear at the end of treatment.  
In only 14 (8%) the *Perforation was healed*.

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pars tensa of the tympanic membrane and in which the annulus tympanicus is not involved.

An *attic perforation* is one situated in Shrapnell's membrane and a *marginal perforation* one involving the annulus tympanicus.

The first table shows the number of dry ears which have resulted from the treatment of the cases divided according to the site of perforation.

For comparison the otoscopic appearances of 200 consecutive cases of past middle-ear infection were recorded and analysed. These are patients who, having been found to be deaf or to have an abnormal tympanic membrane on routine examination, were referred to the clinic, either for advice as to the cause of their deafness or to determine their fitness for overseas service. They are cases of middle-ear infection that have responded to previous treatment or have cleared up spontaneously.

TABLE II

Site of Perforation.	Total.	Incidence of this site of Perforation in treated series.
Healed or dry open central Perforations	182 (91%)	67%
Dry attic perforations	10 (5%)	12%
Dry marginal perforations	8 (4%)	20%

This seems to confirm the finding that cases with a central perforation respond most satisfactorily to treatment and that cases with a marginal perforation are very much less likely to respond to conservative treatment and remain dry.

The 200 treated cases have been further subdivided according to the otoscopic findings.

Table III is this more detailed classification.

Each group is illustrated by a diagram of a typical case and the average length of time taken to obtain a dry ear is recorded.

All the cases with clean central perforation responded well. This is easily the largest group in the whole series.

Even if granulations or small polypi are present these cases respond well to conservative treatment.

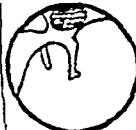
The cases with a central perforation who fail to respond to conservative treatment usually clear up with conservative surgery, such as a simple cortical mastoidectomy. Most of the patients in this group are retained

# The Treatment of Chronic Otitis Media

TABLE III(a)  
CENTRAL PERFORATIONS

	Site of Perforation.	Number of Cases.	Dry Ears.	Average length of time to obtain a dry ear.
CENTRAL		Clean Central Perforation	81 (41%)	81 1-2 weeks
		Central perfora- tion with sessile granulations	43 (21%)	36 2-3 weeks
		Central perfora- tion with poly- poid granulations	9	7 6-8 weeks

TABLE III(b)  
ATTIC PERFORATIONS

		Number of cases.	Dry Ears.	Average length of time to obtain a dry ear.
ATTIC		Clean Attic Perforation	9	9 6-8 weeks
		Attic perforation with sessile granulations	10	8 5-6 weeks
		Attic perforation with poly- poid granulations	2	2 12 weeks
	Attic perforation with enclosed cholesteatoma	2	Nil	—

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in the Royal Air Force for service in this country unless a radical mastoidectomy is considered to be necessary.

In this series all nine cases of clean attic perforation responded well to treatment. They do well if the perforation is sufficiently large as to allow thorough cleaning of the infected part of the attic.

However, it is seen that treatment has to be persevered with for a much longer period.

Even the cases showing granulation tissue or polypi responded quite well to conservative treatment.

Cases with cholesteatoma which cannot be removed through the perforation, as for instance, if it has extended into the mastoid antrum, can obviously only be treated by operative measures.

Cases with attic infection requiring operation respond well to a modified radical mastoideectomy with removal of the incus and amputation of the head of the malleus. This operation allows thorough cleaning of the whole of the attic. If operative treatment is necessary they are only retained in the Royal Air Force if they are valuable trained personnel.

TABLE III(c)  
MARGINAL PERFORATIONS

MARGINAL		Number of Cases.	Dry Ears.	Average length of time to obtain a dry ear.
	 Clean marginal perforation	13	9	1-3 weeks
	 Marginal perforation with sessile granulations	16	8	2-3 weeks
	 Marginal perforations with polypoid granulations	10	3	3 weeks
	Marginal perforations with enclosed cholesteatoma	2	Nil	—

These are the difficult cases to treat conservatively as bone necrosis is often present. When operative treatment is necessary a classical

## The Treatment of Chronic Otitis Media

radical mastoidectomy has often to be performed. It is patients from this group who are most frequently invalidated from the Royal Air Force as a complete radical mastoidectomy is not normally performed on them whilst they are in the service.

Finally, I would like to give some idea of the recurrence rate to be expected in the cases that have responded satisfactorily to conservative treatment.

Over a hundred of the one hundred and sixty five cases who had dry ears at the end of treatment, were followed up for periods of over three months from the time that their ears became dry.

Table IV is a record of these cases.

TABLE IV

Length of time that patient remained under observation after termination of treatment.	Total.	Number of cases with recurrence of infection.
Three to four months	20	Nil
Four to six months	32	2. Both responded rapidly to further treatment
Six to twelve months	38	9. 6 responded to further treatment 3 did not respond and required operative treatment to obtain a dry ear
Over twelve months	11	3. All responded to further treatment

This table emphasizes the fact that cases of chronic otitis media can never be said to be cured while the perforation remains unhealed. It is for this reason that in the Royal Air Force these patients are only considered fit for home service. They can then obtain specialist attention without delay if re-infection occurs.

The cases with central perforations usually dry up in one or two days if treatment is re-commenced at once.

The satisfactory end result of conservative treatment is not dissimilar from the successful result of operative treatment. They both break down under similar circumstances. Operative treatment is much more likely to increase the deafness whereas conservative treatment often

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improves the hearing. However, if the ear is likely to be neglected and further treatment not obtained if a recurrence occurs, some form of radical mastoidectomy is probably a safer end result.

In conclusion I would like to suggest that in assessing the value of any particular treatment for chronic suppurative otitis media the cases should be subdivided, as the prognosis differs so considerably in the three main sites of perforation.

# OPERATIVE TREATMENT OF CHRONIC OTITIS MEDIA

By W. O. LODGE

## Introduction

Chronicity implies degeneration. This is why success from operation cannot be guaranteed and the disease remains such a tantalizing problem. Nevertheless, the proportion of good results is sufficiently high to atone for occasional disappointments, more especially if it can be discerned from successes and failures how the disease can be prevented.

## Living Pathology and its lessons

Out of a welter of observations, the following seem to stand out most clearly.

1. Aural polypi bear the same relationship to chronic otitis media as nasal polypi bear to sinusitis.
2. Between one and two per cent. of the population suffer from the disease.
3. The age and sex incidence of a number of surgical cases is shown in the accompanying graph (see Fig. 1).

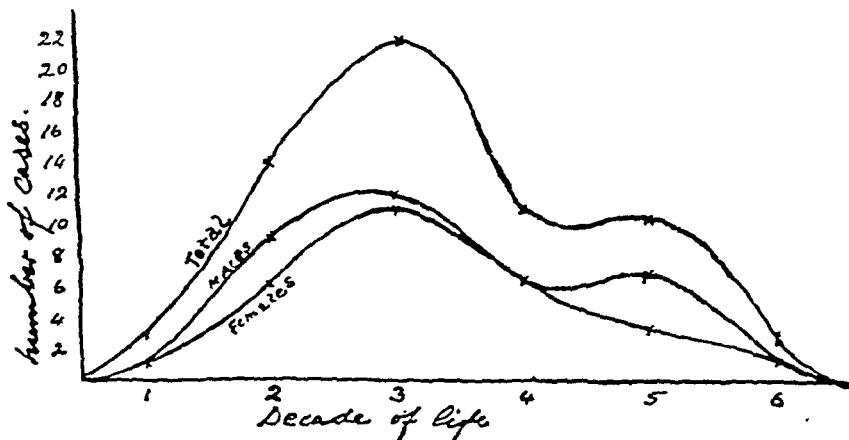


FIG. 1.

Extrapolated graph of age at operation in decades of life for 64 cases. Total corrected by the Medical Statistician to make allowance for the greater numbers of people living in the second, third and fourth decades.

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4. In none of my last 100 operation cases was the chronic otitis media stated to be of less than two years duration, in the majority it was of from fifteen to thirty years standing, generally dating back to infancy. This was usually confirmed by X-ray examination, and by the pathological anatomy. The disease deafens and disables those in the prime of life. The accompanying graph (Fig. 2) shows deaths from intracranial

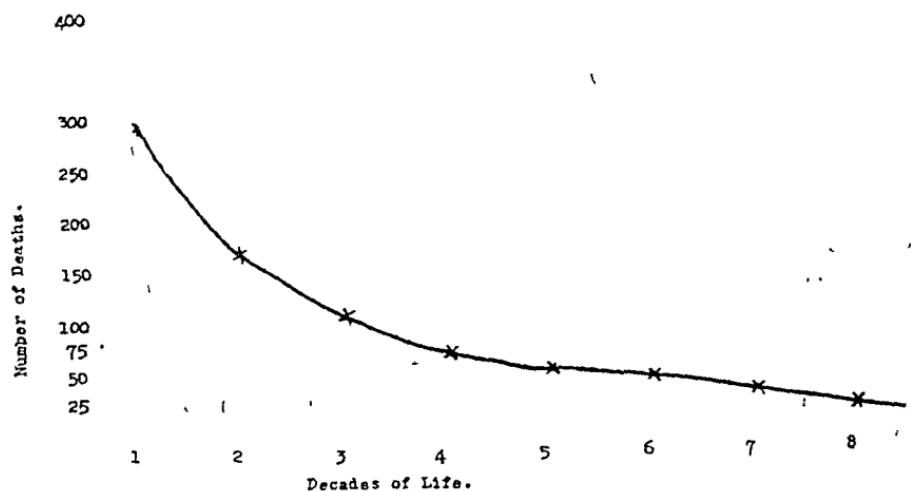


FIG. 2.

Graph showing age incidence in decades of 824 deaths from otitic meningitis, brain abscess and sinus thrombosis in England and Wales in 1925.

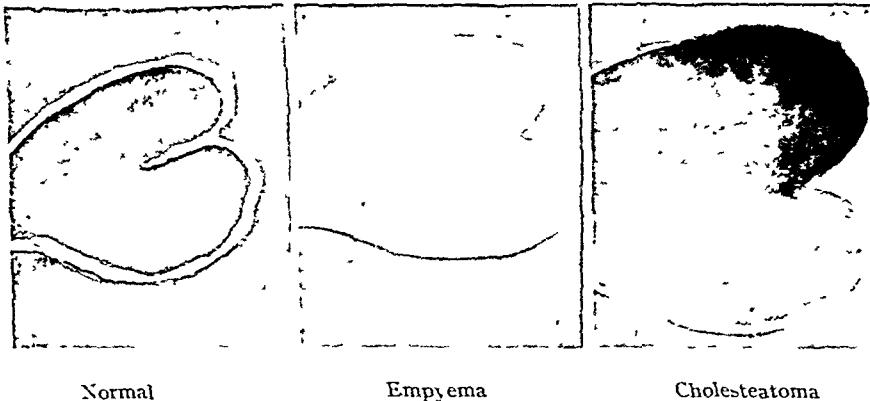
complications of otitis media in decades, compiled from the Registrar-General's statistics. The high infantile mortality is noteworthy: It is with the survivors that we are now concerned. The natural history of chronic otitis media is reflected in the attitude towards it of the Life Insurance Companies.

5. Otitis in infancy is so common that at present there are often two candidates for every available cot. Probably the first two years of life are the most significant, in connection with pneumatization and development of a vitalized mucous membrane.

6. In infancy, non-operative *in-patient* treatment is effective. There is a growing feeling among otologists that infantile otitis ought to be a notifiable disease. Pending such reforms, we have to do our best for an afflicted generation.

7. Virulent strains of diphtheria bacilli, streptococci and other bacteria breed in the recondite recesses of these septic cavities. During the first few days after operations, they flourish on the raw surfaces, denuded of protective barriers, and may form membranes, cause characteristic odours or otherwise stand revealed in their true colours, such as the ephemeral blue on the dressings where *B. pyocyanus* abounds.

FIG 3.  
Diagram of X-ray changes in mastoid air cells (negative)



Normal                      Empyema                      Cholesteatoma

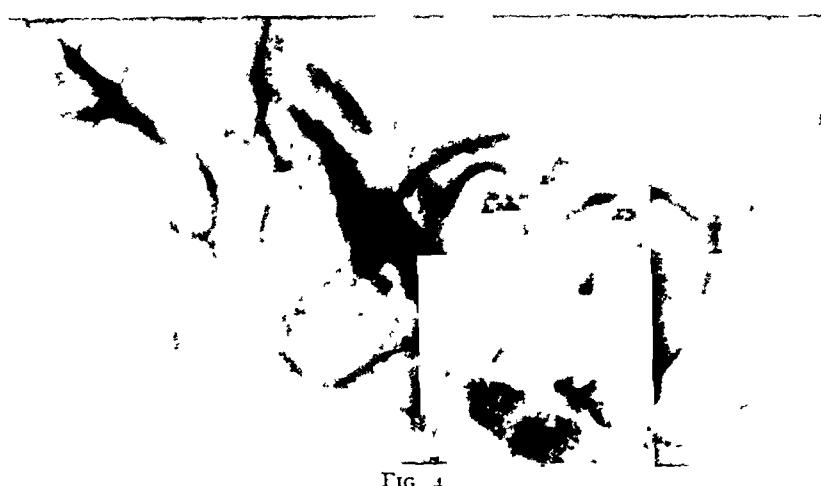


FIG 4

X-ray Temporo mandibular articulation and a large cholesteatoma can be discerned  
(From a positive print )



FIG 5

X ray print showing normal air cells on the right and cholesteatoma on the left

# Operative Treatment of Chronic Otitis Media

8. Pyogenic infections are more curable than tuberculosis or cancer. Not more than five per cent. of cancer patients live more than five years, according to Pack and Livingstone. Few forms of cancer are preventable.

9. In a few cases which are possibly of developmental origin, surgery is less likely to be supplanted. Comparative anatomy—for example, the spiracles and swim bladders of certain fishes—is worthy of close attention; and heredity cannot be left out of account.

## INTERPRETATION OF X-RAY APPEARANCES

Illuminators for skiagrams, let into the wall, are pleasing features of modern operating theatres. Confirmation of a clinical estimate of the grade of pneumatization helps one to decide whether a retro-auricular incision is necessary. Relative dullness is not the only information to be gleaned about an air cell. A mucocele is relatively clear, if the percentage of calcium in the contents be low. A pyocele is relatively opaque. How then are we to recognize a cholesteatoma? The answer is that the arcades of inner table are missing so that there is abrupt transition from cavity to homogeneous bone. (See Fig. 3.) This is due to progressive pressure. In the mastoid such changes, though only to be seen in part, are pathognomonic. (See Figs. 4 and 5.)

## CIRCUMSCRIBED DISEASE OF THE ATTIC

Endaural operations invite simultaneous comparison between otoscopic appearances and underlying disease. Fig. 6 illustrates the middle ear and part of a well pneumatized mastoid of a man aged 35. The attic and antrum are occupied by a thin walled sac, which opens anteriorly in the membrana flaccida. Its duration is uncertain. There is a corresponding depression in the membrana flaccida of the other ear, and only slight otitis externa.

Ten per cent. of my cases of chronic otitis media have been of this type. They are good surgical risks, and to be found in first class lives; but the disability is so slight that operative treatment may be refused. Sometimes the cholesteatomatous membrane is more closely applied to the walls of the attic, and sometimes a polypus is attached to the malleus here it forms part of the margin of the perforation. Histologically, invasion of the labyrinthine wall by tendrils from the cholesteatomatous membrane is sometimes to be seen.

## A COMMON TYPE OF CASE

Landmarks in the field of operation are displayed. Adherent to bone adjacent to the notch of Rivinus, from the auditory springs. The ossicles apparently are not eroded.

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Even the chorda tympani nerve is intact. The patient has been able to hear a C.32 tuning fork by air conduction and the disease is bilateral. A number of such ossicles have been removed for histology.

## ADVANCED DISEASE

The depths of a right temporal bone are exposed in Fig. 8. The patient, a man aged 44, complained only of a boil in the ear; this is shown at the periphery at five o'clock. On masking the left ear with Bárány's sound machine, the right ear was found to be stone deaf. The right ear did not respond to the galvanic test. X-ray films, particularly one taken in an axial projection, showing both mastoids on the same film, confirmed the diagnosis of cholesteatoma. A combination of unrelated pathological processes was found, suggesting that there may originally have been two perforations.

There is an eburnated mastoid and stenosed meatus. The mastoid antrum is at a great depth. The lateral sinus is far forward. There may be an incipient mural thrombus. There are polypoid granulations and osteophytes. This type of chronic otitis media is more common in women. Sometimes, one finds no air cells at all—just ivory.

Here the few mastoid cells are far apart and filled with encysted fluid, having been secluded from the mastoid antrum; secretions normally discharged through the Eustachian tube have been retained, owing to the ectopic lateral sinus.

Deeper still is an expanding cholesteatoma of the type which simulates a radical mastoid operation cavity. The furuncle is part of this picture. It is a genuine furuncle, not a fistula through which bare bone can be felt with a probe.

There is a sequestrum containing vestibular relics. Necrosis of bone is more common in childhood. As the facial nerve is exposed and vulnerable to pressure, the cavity will be packed with sulphonamide powder, not with ribbon gauze.

## BASIC SURGERY

For the healing of a cavity from which bone the seat of chronic osteitis has been evacuated, the main essential is that it should be freely open to the surface for a hundred days. Sulphonamides and penicillin are only antiseptics; they do not promote healing except by keeping infection under control, which is very necessary, in the majority of cases, especially during the first ten days. If infection should gain the upper hand, chemotherapy and syringing two or three times a day with eusol is necessary. If, on the other hand, the cavity is comparatively aseptic, the less the physico-chemical equilibrium is disturbed by chemicals, the fewer exuberant granulations will form, and the sooner healing will be complete. It may seem strange to start by discussing after-treatment,

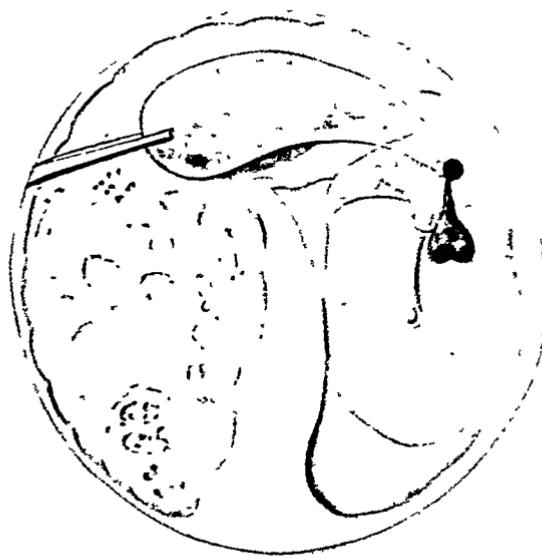


FIG. 6

Circumscribed disease of the attic. A sentinel polypus sometimes hangs from the margin of the perforation, in such cases



FIG. 7.

An operation for the common type of chronic otitis media. A dozen landmarks are displayed.

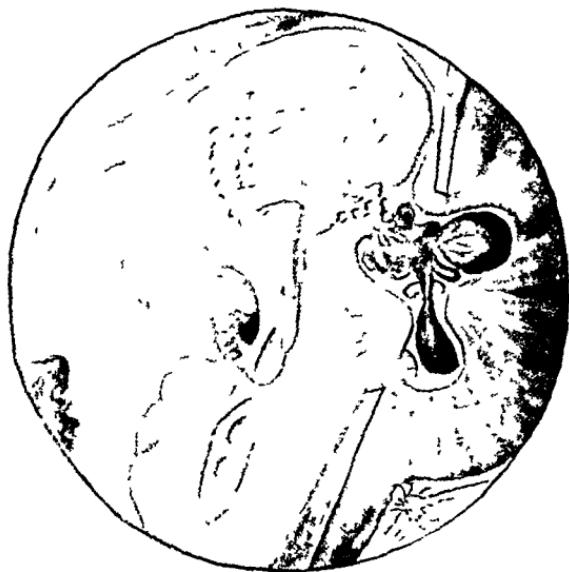


FIG 8

Advanced disease of a right temporal bone. Imminent complications brought to notice by a furuncle

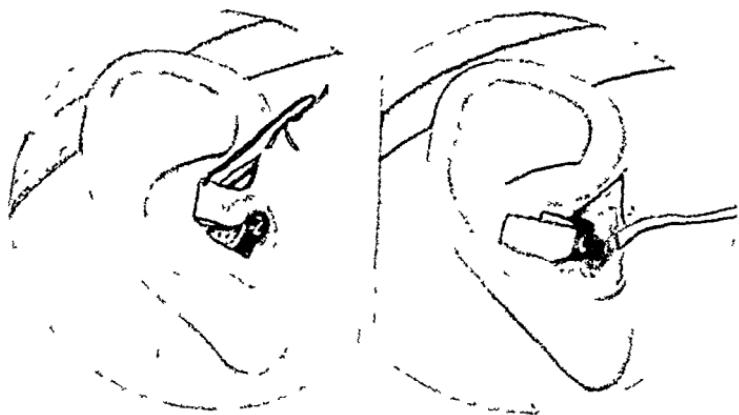


FIG 9

(Left) Meatal plastic (Right) The suture is drawn tight and others inserted



FIG 10.  
Perichondritis—a complication to be avoided



# Operative Treatment of Chronic Otitis Media

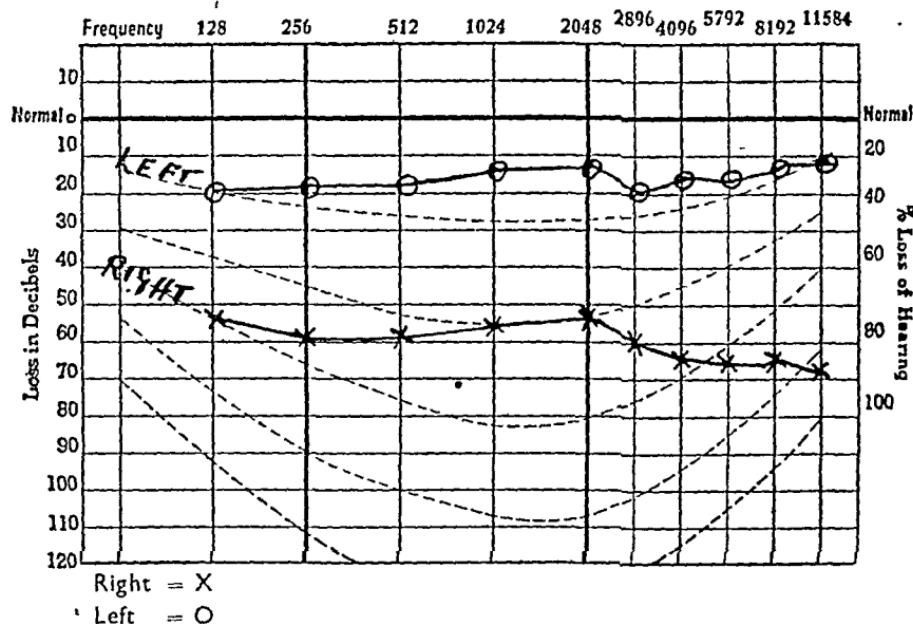
but this is the main theme, to which the operation of access is a prelude. Patients owe much to their devoted nurses.

## Technique

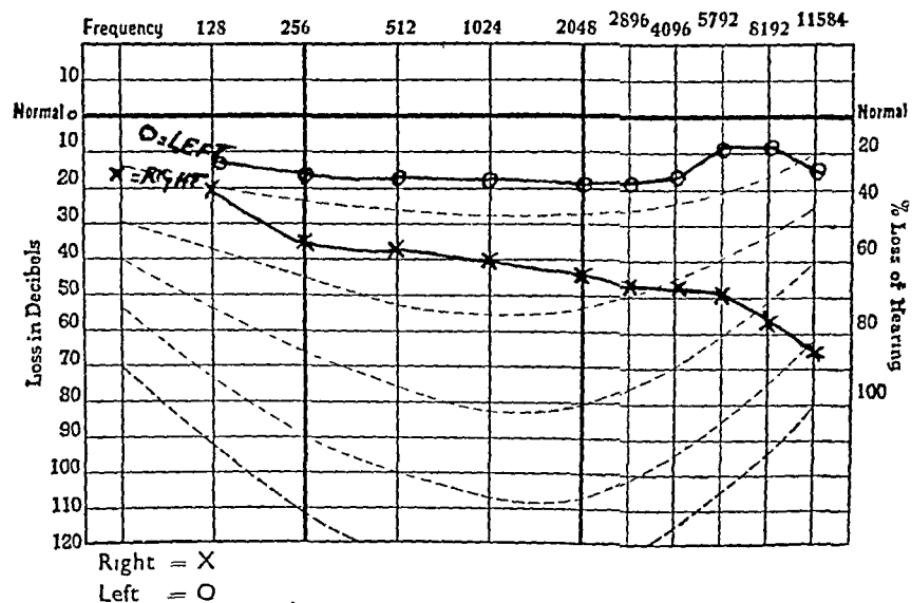
At present, my incision includes a short triangular flap based on the posterior rim of the external auditory meatus, where it joins the cavum conchae. The cartilaginous meatus is scrupulously preserved as the only safeguard against cicatricial contraction. The bone work is completed. Avertin and atropine pre-medication are conducive to a calm anaesthetic and a bloodless field. These temporal bones are so dense that gouges and chisels ought to be resharpened for every case. A good reflected or projected light, a comfortable position seated beside a table adjustable for height are essential. The operation is really a dissection carried out with gouges and a mallet. It is most desirable to leave the inner table everywhere intact, but to remove every vestige of disease, especially from the angle between the tegmen antri and the lateral sinus. To avoid injury to the latter, when the bone is eburnated, as in cases of aural polypus, it is prudent to open into the antrum not through Macewen's triangle, but through the inner face of the bone ; that is, from the meatus. During removal of the "bridge" and the outer wall of the attic, the operation changes its character entirely, in the same way that an operation on the brain alters, when the dura is being opened ; much less force and more delicacy and concentration are required. A lighter mallet may be used. The retractor is removed and replaced when the meatal flap has been unfolded. The root of the zygoma has to be cut away a little, for its reception. The bridge is flattened almost level with the floor of the meatus and the meatus is slit to correspond with this inclined plane. One can learn from mechanical drills and impactor mallets how to wield the more artistic hand instruments with precision. A cell extending towards the sinus tympanic may cause anxiety with regard to the facial nerve ; zeal is to be deprecated here.

A post-auricular incision is only necessary, in my opinion, in chronic cases, if the mastoid is pneumatized ; that is, in about ten per cent. of cases. The transmeatal route gives very direct access, especially in adult males. In children, the concha may be rather small. Fig. 9 (left) shows the last stages of the operation. Transplantation of the triangular flap to the antero-superior extremity of the incision, between the crus helicis and the tragus, unfolds the cartilaginous meatus. The triangular flap, which includes fibrocartilage, is accurately inlaid into its new position, after frosting with sulphonamide. The danger of sloughing is considerable. Catgut sutures are used. The cartilage of the root of the helix is carefully avoided. The surgical anatomy of this donor area for fibrocartilage is of topical interest ; this tissue is sometimes taken for plastic reconstruction of the eyelids.

# W. O. Lodge



Audiograph taken by school medical officer in the case of a girl aged 11 suffering from Chronic Otitis Media (right).



Audiograph taken by school medical officer in the same case as above, after operation on the right ear.

# Operative Treatment of Chronic Otitis Media

The gap left posteriorly affords good access to the cavity. It is good practice to apply a skin graft to the granulating area posteriorly on about the fourteenth day, when infection has subsided. In Fig. 9 (right) the graft is shown beneath a piece of Lister's green silk protective.

A warning is necessary about flavine emulsion, and probably to a less extent, about proflavine and sulphonamide powder. Patients are apt to become sensitized to these favourite preparations about the fourteenth day and develop dermatitis, which may progress to perichondritis of the auricle. (See Fig. 10.) The possibility of the latter complication should be borne in mind in infiltrating the concha, preparatory to the first incision; only one needle puncture should be made, with the strictest precautions. Supply of blood to the pinna should not be restricted, either by undue retraction or by ligature of the post-auricular artery.

## Results

Healing has been complete in 78 out of 100 cases. Successful results exclude those in which only the mastoid cavity proper is healed, but

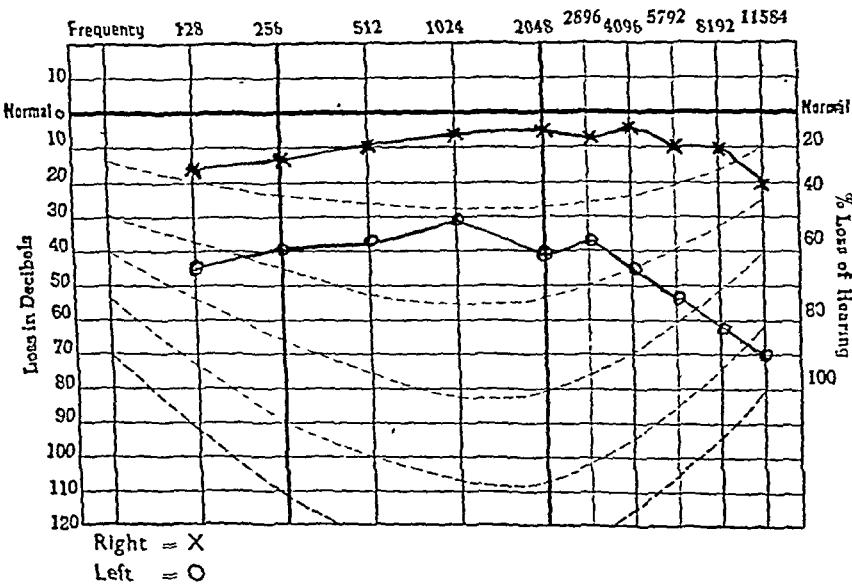


FIG. 12.

In another case the school medical officer commented on this audiograph "He seems to have had a transmeatal operation; he answers readily and is aware of no disability."

include cavities which remain dry, provided keratoses are not neglected. There had been previous mastoid operations in three cases. There were three transient and one temporary paralysis of the facial nerve; one candidate spontaneously developed facial paralysis on the eve of operation.

# W. O. Lodge

Perichondritis occurred three times. There was one death from a concomitant precerebellar cyst. In my opinion, the risk over a period of five years is less with operation than without it, and the commonest cause of failure is pus under pressure. Arrival with a letter from the doctor and bag packed for hospital should not lull suspicion, in dealing with a disease so treacherous as chronic otitis media.

One could rhapsodize about the perfection of successful operations—the extinction of the osteomyelitis, the nacreous lining of the cavity and the *restitutio ad integrum* of the organ of hearing. Even ten decibels of hearing regained is an inestimable benefit. (See Figs. 11 and 12.) That many an operation might have been prevented is a sobering reflection.

## Summary

Operations by the endaural route allow observation of living pathology and correlation with X-ray appearances of pneumatization, harmonizing treatment with surgical principles, and affording research into the prevention of chronic otitis media.

Three lithographs depict the circumscribed, the common and the complicated type, respectively.

The newer antiseptics affect after-treatment. The transmeatal approach is described and figured. Measures to enlarge the lumen of the meatus and avoid perichondritis are discussed.

Out of 100 cases, healing has been complete in 78.

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## LOCAL CHEMOTHERAPY IN PARANASAL SINUSITIS

By J. ANGELL JAMES, LT.-COL. R.A.M.C. (Bristol)

IN January 1941 a sulphonamide paste was prepared for injection into the paranasal sinuses for the treatment of sinusitis. (1) When the method was first described only a few cases had been treated. It has now been under trial for 4 years, but owing to the War a complete follow-up of a controlled series of cases has not been possible, and the claims made in this paper must be regarded as tentative, pending a more extensive investigation. Since its introduction the principle of the method, which is a logical development of the well established technique of the treatment of sinusitis by puncture and lavage, has remained unchanged; but alterations have been made in the composition of the paste, and Proflavine and Penicillin have been added.

### Principles of the Method

The paranasal sinuses are particularly favourable sites for local chemotherapy, because pus can be thoroughly washed out of them by puncture lavage and their cavities subsequently filled with paste. The sinuses empty themselves of mucus, pus, or other fluid contents partly by gravity, partly by ciliary action. For this reason, to avoid unnecessary interference, and to allow ample time for the bacteriostatic power of the sulphonamides to exert its effect, a paste was prepared of such a viscosity, that a considerable proportion of the volume injected would persist in the antrum for approximately a week. The correct consistency was determined by trial. Barium sulphate was added to the trial pastes and their expulsion followed by serial skiagram.

A mixture of Sulphanilamide 2 parts, Sulphadiazine 1 part was chosen to ensure a high initial concentration of the soluble Sulphanilamide active against the haemolytic streptococcus, together with an adequate reserve of the much less soluble Sulphadiazine to maintain a reasonable concentration for a week. At the same time the Sulphadiazine was of value for its more powerful action against pneumococci, staphylococci, *B. coli*, *B. Friedlander*, *H. influenzae* and diphtheroids, which may be present in infected sinuses. Proflavine was added because it is active against most pathogenic bacteria, is relatively non-irritating to normal tissues when suitably diluted, and, unlike the sulphonamides, retains its activity in the presence of pus. Penicillin has been used only during the last 10 months.

# J. Angell James

Experiments with these pastes have shown that the Proflavine and sulphonamides are still bacteriostatic after lying in the antrum for a week, while Penicillin retains its activity only for 5 days.

For this reason antra were refilled once a week when using the Proflavine sulphonamide paste, every 5 days when using the Penicillin sulphonamide.

Since September, 1944, alternate cases have been treated with the Proflavine and the Penicillin pastes in an attempt to assess their relative values. Up to date there have been more successes with the latter, and further details will be published later. It seems probable that the choice of paste should be decided in each case after consideration of the Bacteriologist's report on the washings.

The first base used was starch paste 1 in 20. This was chosen in order to render the sulphonamide freely available for diffusion into the mucous membrane. There proved to be many difficulties in the preparation of the starch paste, and there was a tendency for the sulphonamide to crystallize and block the cannula during injection. In 1943, at Mr. R. G. Macbeth's suggestion a Lanette Wax Oil cream was tried. This interfered with the diffusion of the sulphonamide and was later replaced by a simple Lanette Wax cream without oil.

## Preparation of the pastes

1. The Proflavine sulphonamide paste is now prepared as follows:

Pulv. Sulphanilamide .. .. ..	2	20%
Pulv. Sulphathiazole or Sulphadiazine ..	1	
Proflavine sulphate		
(neutralized with Soda. Bicarb. $\frac{1}{4}$ part).		0.2%
Lanette Cream		
16% Lanette wax SX in water ..		79.8%

Melt the Lanette wax, add the water and when thoroughly mixed add the sulphonamide and Proflavine powders. The paste is sterilized in the autoclave in 17 c.c. (glass) containers, with screw cap just loosened, at a pressure of 10 lbs. per square inch for 15 minutes. Each container holds sufficient paste to fill a large antrum. This paste will persist in the antrum for a week.

2. *Penicillin sulphonamide paste is prepared in two stages on account of the instability of Penicillin at high temperature in solution.*

Sulphonamide paste without Proflavine and using 18 per cent. Lanette cream is prepared and sterilized as described above. When it is required for use, 15,000 units of Penicillin are dissolved in 2 c.c. of sterile water, mixed with 14 c.c. of the paste in the container and it is then ready for injection. This paste will persist in the antrum for 5 days. The length of time required for antra to empty themselves varies considerably in

# Local Chemotherapy in Paranasal Sinusitis

different patients, and may be longer but rarely shorter than the periods given above. It may be necessary to alter slightly the percentage of Lanette wax to allow for different climatic conditions, and minor variations in the method of preparation in the hands of different individuals.

## Method of Application

1. Under local or general anaesthesia the affected sinuses are punctured or catheterized. A specimen is taken for culture and for testing the sensitivity of the organism to Penicillin.

2. The sinuses are washed out vigorously until washings and fluid aspirated by syringe are clear.

3. The barrel of a Watson-Williams syringe is filled with the paste and the paste injected into the sinus until it overflows from the ostium and can be seen in the nose. The volume of paste required to fill the sinus is noted.

4. The puncture lavage and if necessary paste injection is repeated ; after one week when Proflavine sulphonamide paste is used, after 5 days when Penicillin sulphonamide paste is used.

5. The process is repeated until the washings are clear, or it is apparent that no further improvement is taking place. I have not punctured and injected a sinus more than 5 times in succession in this series.

6. Polypi should be removed, and other causes of nasal obstruction corrected, to reduce the likelihood of recurrence of infection.

7. All affected sinuses should be treated simultaneously if possible otherwise cross re-infection of a sinus is liable to occur.

## Selection of Cases

The method is most suitable for the treatment of antral and sphenoidal sinusitis, and for the reasons given below should not generally be used for the following :

### 1. Early stages of acute sinusitis

General sulphonamide or Penicillin therapy is more suitable for early acute sinusitis. The majority of such cases will clear up with intensive conservative treatment. Any surgical interference of even such a minor degree as puncture at an early stage is liable to precipitate an osteomyelitis or generalized blood infection. However there have been a few cases for which it was required in the early stages on account of severe or intractable local or general symptoms, and in them it proved to be successful. It has been my practice to reserve puncture lavage and injection of paste for cases which have failed to respond to conservative measures, or in which recovery was unduly delayed. In acute sinusitis it is rarely indicated before the second or third week.

# J. Angell James

## 2. *Frontal Sinusitis*

Cases of frontal sinusitis respond particularly well to conservative treatment, provided that any accompanying infection of antra or ethmoidal cells is cleared up. It is difficult, and often impossible, to introduce a cannula of sufficiently large calibre to allow the passage of the paste without injuring the fronto-nasal duct and surrounding ethmoidal cells. Stenosis of the fronto-nasal duct is liable to follow such an injury. The method is useful, however, when a catheter passes easily, and for cases which have failed to clear up after operative drainage.

## 3. *Ethmoiditis*

For anatomical reasons it is not possible to puncture, wash out and fill every ethmoidal cell. I have seldom used the method for adults. In children, however, it is worth while washing out and filling the posterior cells, and at the same time performing any operation (removal of adenoids etc.) which may be necessary to establish a free airway.

## 4. *Complicated cases*

The treatment is no substitute for radical surgical procedures when sinusitis has led to osteomyelitis or extra-sinus and especially intracranial complications.

## 5. *Cases with gross mucosal thickening*

Effective concentration of these drugs is probably limited to a depth of  $\frac{1}{2}$  cm. after surface application. The presence of gross mucosal swelling in the sinuses is therefore an unfavourable factor. Cases in which polypi are associated with mucosal swelling in the sinuses do not respond well. On the other hand some patients with long standing suppurative sinusitis and marked mucosal swelling have made a good response (notes of an illustrative case at end of paper). Other things being favourable, gross mucosal swelling alone was not considered an absolute contra-indication.

An estimate of the thickness of the mucous membrane is made by

- (i) comparing the volume of paste required to fill the antrum with the size as shown in the skiagram.
- (ii) measuring the distance the cannula requires to be withdrawn after impinging on the posterior wall before the contents of the antrum can be aspirated, or
- (iii) filling the antrum with opaque oil and taking a skiagram.

## Comparison results of Treatment of Cases of Suppurative Nasal Sinusitis with and without paste

### *Criteria of Success*

1. Antral washing perfectly clean.
2. When subsequent review was possible, absence of signs and symptoms and skiagram clear (2 or 3 millimetres of residual mucosal swelling was ignored) after 4 weeks.

# Local Chemotherapy in Paranasal Sinusitis

Two series of figures are presented, the first being those of private and Bristol Children's Hospital cases for 1941 and for four months of 1942 treated with paste, compared with similar cases treated without it in 1939.

The second series for which I have no control group, consists of service patients treated at home and overseas.

The cases treated with paste were selected according to the principles described above. The 1939 group treated by puncture lavage without paste were less severe on the average, because the more severe were advised operation without trial of conservative treatment.

	Without paste (1939)	With paste (1941-42)
<b>PRIVATE PATIENTS</b>		
Total	31	40
Successful	10	35
Percentage successful	32%	87%
<b>BRISTOL CHILDREN'S HOSPITAL</b>		
Total	36	36
Successful	15	31
Percentage successful	41%	86%
<b>SERVICE CASES (1942-45)</b>		
Total		126
Successful		89
Percentage successful		70%

## Illustrative Case History

Miss A. æt. 79 years. Referred by Dr. R. Kemm. History of copious offensive greenish discharge from the right side of the nose for 30 years.

She had been seen by Mr. E. R. Chambers on account of severe retino-choroiditis which was considered to have been caused by a septic focus. Thick offensive pus was washed out on puncture of the right antrum. Lavage was very difficult and painful on account of gross mucosal thickening leaving only a 4 c.c. lumen containing viscid pus.

After a series of 10 punctures there was no improvement. A radical operation was suggested but, owing to the patient's cardiac condition, it was not considered advisable. Three years later (1941) she was seen again with a severe progressive perception deafness, her vision deteriorating and the nasal condition unchanged. Puncture lavage and sulphonamide paste injection of the right antrum was performed. A week later the patient reported that her nasal discharge had ceased entirely and she had a free nasal airway for the first time in 30 years. Two weeks later an antral puncture and lavage gave a free and perfectly clear he capacity of the antrum had increased to 8 c.c.

### Summary

The treatment of nasal sinusitis by local application of Proflavine sulphonamide and Penicillin sulphonamide paste is described and the selection of suitable cases discussed. Puncture lavage and injection of paste at 5-7 day intervals is recommended for cases of suppurative sinusitis not responding to conservative treatment. The usual conservative treatment is continued throughout.

The antrum and sphenoid are the most suitable sinuses for this treatment.

An analysis of results of treatment of cases before and since the introduction of the method in 1941 shows a significant improvement in the latter group.\*

Detailed references are omitted on account of lack of access to literature.

My thanks are due to Colonel G. T. Garraway for permission to publish this article; to Major A. C. Jones, R.A.M.C. for his work on the bacteriological aspect of it, and to Major Scott Thomson, R.A.M.C. for suggestions on the method of using Penicillin.

\**Proc. Roy. Soc. Med.*, 1941, xxxiv., 671.





Micro-photograph of Actinomycotic Granule in Pus near Pterygoid Plate.  
( $\times 100$ )

## CLINICAL RECORD

### FATAL ACTINOMYCES INFECTION OF THE MIDDLE EAR

By V. TOWNROW (Sheffield) and H. J. BARRIE (Sheffield)

CONSIDERING that *Actinomyces bovis* is a natural inhabitant of the oral cavity, it is surprising that it so rarely acts as a secondary invader in disease of the middle ear. The following case illustrated that it may sometimes do so.

The patient J.H.F., aged 64 was a horseman who had had intermittent foul yellow discharge from the left ear for 57 years. Three months before admission to hospital, he had had pain inside the left ear and for three weeks, pain on the left side of the top of the head. Eight days before admission, the left ear had bled copiously and this was followed by recurrent bleeding from the ear and nose.

On admission, he looked ill and pale, his blood pressure was 110-80, pulse 88, respiration 22, temperature 99.8 and haemoglobin 85%.

Bleeding continued intermittently from the nose and ear. On the next day, a painful swelling appeared in front of the ear and he complained of severe pain on the left side of the head. He then had a rigor. He was given two pints of blood intravenously and the mastoid region was then explored. At operation the bone was found to be very dense. Haemorrhage occurred from the anterior part of the antrum and very marked venous bleeding from a vascular mass in the middle ear. Packing was necessary to control the bleeding.

The next day his temperature reached 102.4. A lumbar puncture produced C.S.F. containing 180 mgm. per cent. of protein, 720 mgm. per cent. of chloride and 264 cells per c.mm. (54 per cent. polymorphs, 44 per cent. lymphocytes, 2 per cent. monocytes). A gram stain of the deposit showed no organisms, but a few colonies of *Streptococcus viridans* grew after aerobic culture on blood agar. He was treated with Sulphanilamide but went down hill rapidly and died two days after the operation. Autopsy was performed eight hours after death.

#### Summary of Autopsy Report

Thin man. Slight protrusion of both eyes. A few very dirty carious broken teeth in lower jaw. Recent left mastoid wound.

The anterior third of the left lateral sinus was completely obliterated by tough fibrous tissue and there was oedematous grey fibrous thickening of the dura of the middle fossa. The roof of the middle ear and petrous part of the temporal bone was eroded and replaced by an irregular lobular swelling approximately  $3.5 \times 2 \times 2$  cm., consisting of a cavity with tough walls and smooth but isolated lining. This mass was adherent to the jugular bulb and on with the left internal carotid artery. It was surrounded by clot and necrotic tissue which extended along the course of

## V. Townrow and H. J. Barrie

the Eustachian tube. The medial pterygoid lamina was necrotic and a small piece of it formed a sequestrum. Thin brown pus infiltrated the pterygoid muscles and masseter. The under surfaces of the left temporal and frontal lobes were flattened and discoloured by brown subdural pus and there was a little loculated greenish subarachnoid pus but no intracerebral abscess.

The sphenoid and ethmoid air sinuses were clean.

The stomach and small gut were full of dark red blood.

Nil of note in remaining organs.

Microscopical examination showed the lobulated mass in the middle ear to be composed entirely of laminated thrombus. In the surrounding blood clot and pus there were colonies of *Actinomyces*.

### Discussion

Risch (1939) collected 29 reports of actinomycosis of the ear. Of these 17 described infection of the external meatus or the pinna and only 12 related to the middle ear. To these 12 must be added a case described by Beck (1906), 2 cases by Nowack (1938), a case by Cann and Hollis (1931) and the case described in this paper, making 17 cases in all. This low figure is a striking index of the rarity of the condition.

A study of these cases shows that most authors considered that the infection spread up the Eustachian tube from the pharynx though proof of this was difficult.

All these cases were fatal except one, that of Pinaroli (1910) who described an acute otitis media which cleared up. We have been unable to consult the original paper describing this and so cannot comment on the case.

Death was due to meningitis in 11 cases, "cerebral involvement" in 2 and to an unspecified cause in 2. Our case is the only one described in which severe haemorrhage was the presenting feature. Our patient had had a discharging ear for 57 years and the lateral sinus thrombosis was also obviously of long standing. Streptothrix infection must have supervened on an old chronic otitis though when, it is impossible to say. A feature of nearly all published cases was the symptom-free nature of the disease till very shortly before death.

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SOCIETIES' PROCEEDINGS  
ROYAL SOCIETY OF MEDICINE—SECTION OF  
OTOLOGY

May 4th, 1945

*President*—L. GRAHAM BROWN, F.R.C.S.

**Discussion on the Treatment of Chronic Suppurative Otitis Media\***

DR. A. R. FRIEL said that in all cases the basic factor in the ear keeping up the discharge was sepsis. In some cases there might be an additional factor such as a polypus or an infection in a neighbouring organ. The diagnosis of the ear condition was made after careful cleansing followed by suction with a Siegle's speculum. If the area of sepsis was accessible in its whole extent and no other factor besides sepsis was present zinc ionization was an excellent method of treatment. The majority of these tympanic cases needed only one ionization and when examined in a week were found to be dry. If a little discharge persisted Boracic acid powder was insufflated. Very few needed a second ionization. No treatment whatever was given to the ear between visits once a week. The strength of zinc sulphate in the solution used was a quarter of 1 per cent. and the average dose was represented as 3 milliameters for 10 minutes. In his experience the size of the perforation (provided the tympanum could be filled) or the duration of the discharge was not important. If the area of sepsis was not accessible in its whole extent some form of operative treatment was indicated.

There are three reasons why zinc ionization is successful. First of all the zinc ion alone is introduced from a solution of a zinc salt at the place to be treated. The direct electric current is the only agent known to medicine by which this can be done. As the zinc ion travels towards the negative electrode it replaces positive ions. The ionic value in the exudate and superficial cells is not altered. Secondly the zinc combines with albumin to form a precipitate and this is not an irritant to subjacent cells. Thirdly the zinc ion is an anti-septic. In short there is antisepsis without irritation. This is the secret of its success.

MR. T. B. JOBSON congratulated the three authors very heartily indeed on their most instructive papers. One point which had struck him, he remarked, was the necessity for frequent and continued treatment in cases of the type in question. In the hospitals they very often saw the out-patients once a week, and then the patient was seen and given some treatment and left to his own devices until he came to the next out-patients' department. It was evident that that was not a very efficient way of treating chronic cases of suppurative otitis media, and he thought that the hospitals ought to have some method of continuous treatment, because it was evident from the papers read that morning that continuous treatment was very much superior to the slapdash treatment which was very frequently given in the ear departments of hospitals.

\* Opening papers on pp. 303 seq.

## Societies' Proceedings

He would like to give his experience of ionization, as Mr. Friel had brought the subject up. It had been most favourable. He had been using the method for over twenty years, and he found that in a large number of cases the results were most satisfactory, and even dramatic ; the effect was very rapid, more rapid than any other method of local treatment. He would like to emphasize, however, that the cases had to be carefully diagnosed ; the method was not, of course, suitable for all and sundry cases of suppurative otitis media. The keynote, in his opinion, was accessibility ; it must be possible to wash out the middle ear and get the solution right into the Eustachian tube to have any chance of a successful result.

He did not think that a small amount of granulation was a bar to success, because that could be very often burnt off with nitrate of silver. From a common sense point of view one must not expect a successful result from ionization in an attic condition with a tiny perforation ; he had tried it in many cases of that type, and none was a success. A case of attic suppuration with a small perforation, or, as was frequently found, a little sinus running up under the posterior ligament or the anterior ligament of the malleus, and the lower part of the tympanic membrane firmly glued to the inner walls, was, in his opinion, quite unsuitable for zinc ionization. When one thought of the mechanical position involved, with a mass of matter up in the attic with sepsis, one would see that it was quite impossible to wash out through that tiny perforation any matter (usually cholesteatomatous) which was contained there, and it was, of course, useless to sterilize by zinc ionization a small part of that cavity, because, although there might be an improvement for a few days, the sepsis would spread and the condition would become the same as before. He would emphasize, therefore, that there must be an open tympanic cavity and a perforation through which the material could be washed out ; but, given those conditions, he thought that ionization was the most satisfactory and the most rapid method of gaining a successful result.

MR. H. V. FORSTER said that for the removal of Aural Polypi, by twisting under local anaesthesia, he had found most useful the spring cross action grasping forceps of Wingrave. Otherwise he treated the growths with the Chromic Acid bead.

With regard to Mr. Johnston's remarks about the influence of the respiratory and palatine tonsils on the middle-ear cleft, he, Mr. Forster held conservative views about the influence of the palatine tonsils.

He thought treatment by syringing a very useful form of treatment in cases of otitis media. It could be used by the patient or the nurse without the more frequent attendance of the otologist.

Our nurses might be encouraged to use the head mirror. He had seen them do so in the late Mr. Tweedie's clinic at Nottingham.

Squadron-Leader Banham's paper recalled that perhaps after this war the cost to the Ministry of Pensions might be less in cases of otitis media, where aggravation of old disease was allowed. The examination by specialists of recruits referred by the Ministry of Labour medical boards must have "weeded out" a great number of such cases, including those with radical mastoid cavities who did not stand active service well.

# Royal Society of Medicine

Mr. Lodge had called attention to the influence of heredity in inflammatory middle-ear disease. His own experience suggested a very marked influence.

LIEUT.-COMMANDER H. D. BROWN KELLY said he was hoping later to publish figures for a naval hospital. He had analysed the records covering a period of four years. He himself had not been in the hospital for as long as that, but he had had access to the records. The main point which had struck him was the enormous incidence of chronic ear disease, which accounted for something like 30 per cent. of the cases dealt with in the E.N.T. department of the hospital. The disease was serious in the Navy, because a sailor with chronic suppurative otitis media had to be treated as an in-patient. It was very seldom that he was in a place where specialist out-patient treatment was available. The radical mastoid case was no use in the Navy at all, and the sailor who had had that operation was useless both for sea and for shore service away from specialist advice. The hospital had access to a good deal of penicillin which had been tried for chronic suppurative disease, but he did not think that it had shown much advantage over boracic powder or boric and iodine.

MR. I. A. TUMARKIN said he would have liked to hear more discussion about the question of function in suppuration. The function of the tensor tympani was believed to be that of protecting the ear against loud noises, but that was a curiously anthropocentric idea, for, after all, the tensor tympani had been developed in animals millions of years ago, when loud noises were unknown. It was far more likely that the tensor tympani was essential for the proper act of hearing. If one wished to understand its function one should look to the physicist, who also used apparatus for detecting sound. The physicist described two types of microphone. There was the velocity microphone, in which a strip of aluminium was delicately poised in the path of the sound wave and was affected by the actual velocity of the air particles, moving freely, and there was the pressure-driven microphone, in which a crystal (it was usually a crystal instrument) was held firmly and tensely and reacted not to the velocity of the air particles, because it hardly moved at all, but to the pressure. He had no time on the present occasion to go into the evidence, which he hoped to publish later, for holding that the middle ear was a pressure-operated instrument and not a velocity-operated instrument, but if that was the case the function of the intratympanic muscles was obviously that of maintaining the necessary tension. When those muscles contracted the tympanic membrane was drawn in, and there was the set-up for a pressure-driven instrument.

It was now possible to consider the functional effect of different types of suppuration. With the central perforation the mechanics of the middle ear were comparatively unaffected, and that was why the hearing in those cases was commonly quite excellent. Similarly, in the attic perforation, in which the infection was located in the anterior pouch of Prussac, there might be no effect; but in post-superior perforation, where the infection was located in the antrum, the whole function of the intratympanic mechanism might be destroyed. Not only the impedance matching effect, which was the classical theory, but also the pressure effect which he had just mentioned. It was interesting to note from Squadron Leader Banham's statistics that the post-superior infection was the one which most obstinately resisted treatment,

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and also, he thought, was most liable to relapse ; yet that type was the one which was most liable to destroy the hearing.

Because of that, he would make a plea for a more urgent attitude towards the problem. He would be the last to recommend precipitate surgery, but he felt that with the post-superior perforation, once the surgeon was satisfied that his conservative treatment was not likely to produce a rapid cure, he ought to consider further measures. In that respect the classical operations were not, he believed, satisfactory ; the procedures were altogether too massive, and it was not possible to attain the precise type of surgery which was essential if one was aiming at a functional result as well as a mere suppression of infection. Because of that he had for some years adopted the method of transmeatal atticotomy. A simple, localized procedure aimed directly at the focus of infection in the attic and in the antrum. There was no attack on the mastoid cortex, the cartilage was never touched. He merely turned down a small flap from the outer attic wall and removed the immediate focus of bone. This operation, if successful (and he thought that his results were equal to Mr. Lodge's), produced a tiny cavity lined with healthy skin, and a functional result which he thought was superior to that of most of the standard procedures.

BRIGADIER MYLES FORMBY mentioned one or two points in connection with the problem under discussion which had arisen in the Army, and which he thought might be of interest. He had, he said, unfortunately not been successful in getting any accurate figures of the number of cases with which they had had to deal. He need not weary the meeting by giving the reasons, but, it was quite impossible ever to put it on a percentage basis when such a limited number of people knew the actual number of troops in any area who were being dealt with by the E.M.S. and military hospitals in that area. The cases coming to ear, nose and throat departments of military hospitals during the last three years showed on analysis that almost exactly a quarter of the work had been in dealing with chronic suppurative otitis media, and in general terms it had been about 12 per cent. of the total out-patient work in the limited number of military hospitals in which they took statistics. Taking the cases reporting to regimental medical officers and camp reception stations and the so-called first aid posts for the Army all over the country, during 1943 there were approximately 1,000 cases reporting on account of their ears every week—just over 50,000 a year—and of those more than half were chronic suppurative otitis media. He thought that any otologist with any experience of the Army would say that those cases were of little use to the Army, and it would have been far better to exclude them. It was his firm conviction that for any standing army, any regular army or any army for future wars men with chronic suppurative otitis media should be excluded. It was necessary, however, to take account of the man-power situation, and that was really the answer to the number of cases of chronic suppurative otitis media which were at present in the Army ; those men had to be accepted and the best possible use made of them.

If that situation should arise again, he thought it should be stipulated that those cases should be very carefully assessed at the time that they were admitted by people able to assess pathological conditions in the ear and also knowing the jobs to which those men would be directed in the Service, to see that they were

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properly placed. The introduction of the A.T.S. in the Army had been a great success, and there was no reason why people with a disability such as chronic suppurative otitis media should not do a useful job of work ; but it was no use putting them into a regiment which was going, say, to Burma, and then having to send them all the way home again.

Mention had already been made of the use of penicillin. Probably most of the members would be familiar with the work which Major Collins did at the Royal Albert Hospital last year and at the end of 1943, which briefly went to show that penicillin in the treatment of chronic suppurative otitis media was useless, the reason being that the secondary organisms immediately flourished the moment the penicillin-sensitive organisms were removed.

Finally, he strongly deprecated Mr. Forster's suggestion that nurses should be taught to hold mirrors in their mouths. If they were going to clean out infected ears they should wear masks, because reinfection and mixed infection was responsible for a great deal of trouble.

The PRESIDENT said that from long experience it was probable that most otologists had come to consider the problem under discussion in much the same way as he did, i.e. as a question primarily of promoting drainage. Considering the number of medicaments used in the last thirty years, and even the zinc ionization method of Mr. Friel, one came to the conclusion that any method of cleansing the ear so as to promote drainage was good. Whether one used boracic acid lotion, which was all that he used nowadays, to cleanse the ear, or any of the other drugs and medicaments, such as mercury drops and so on, and now the application of the sulphonamides and penicillin to form creams or lotions, it all came to the same thing : one was promoting better drainage.

He did not like the term " syringing " in otology, because it had given a bad name to the profession through the dangers attributed to it, but he had always advocated cleansing the ear by what he called irrigation. It amounted to much the same thing—syringing gently with an ordinary or a Higginson syringe. He thought that that was the best method of cleansing the ear, instead of by swabbing. He used swabbing, by means of a cotton wound applicator, only in those cases where it was desirous to remove adherent pieces of debris or membrane in order to get a better view of the drum head. For ordinary cleansing he used the method of irrigation in his clinics, and he thought it was essential to establish such clinics for the continuous treatment of such ears.

Perhaps theoretically Dr. Friel was right in using some method which would directly attack the organism *in situ*, but, as Dr. Friel himself agreed, the application of that method was limited to certain cases. The time might come, perhaps, when they would use sulphonamide drugs or penicillin or similar therapeutic agents for direct attack on the organisms *in situ*, but by systemic and not local application. He saw no method at present of getting directly at the organisms in the middle-ear cavity. He agreed that cleansing the meatus with no matter what kind of medicament, did limit the tendency for the continuation of the discharge. For the same reason he would still advocate the removal of polypi or granulation tissue by the various methods in order to promote better drainage. Some cases cleared up very rapidly when treated

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in that way. However there should be operative treatment in selected cases, and he thought that those were, as had been remarked, particularly the post-superior marginal and attic types where conservative mastoidectomy must play its part.

MR. COLIN M. JOHNSTON, in reply, said it would not be possible to attempt to reply to all the points which had been raised, but he would like to say something about zinc ionization. He must admit that he had tried it only as a "last ditch" method when everything else had failed, and not, of course, in the postero-superior type of perforation, but rather with the anterior or central type. With regard to acetone, an explanation given to him by Mr. Cawthorne was that it probably acts by virtue of its solvent action on grease in the debris in the middle ear. It caused some pain the first time it was used but subsequent applications gave rise to less pain.

It was obvious that there was a very great need for more ear, nose and throat surgeons, and for an extension of the ear, nose and throat service in the health services of the country.

He agreed that syringing would cure almost any ear which was capable of being cured by cleansing methods. His only comment would be that in the E.M.S. hospitals he had seen a large number of infected perforations due to blast; many of them he had not had the time to treat individually by mopping and the patients were in medical wards where the attention was not skilled. The nursing staff were told to syringe the ears and let him know when the discharge stopped. He was convinced that those ears took much longer to dry up than the ones treated by mopping.

SQUADRON-LEADER T. M. BANHAM, in reply, referred to upper respiratory infection and said he had been very surprised at the very small number of respiratory infections associated with chronic middle-ear suppuration in Service patients. Of his 200 cases, only 2 had a tonsillectomy performed, and 2 had a chronic infection of the antrum. With regard to the function of the middle ear, they had found that those cases treated for chronic suppurative otitis media who obtained a dry ear were much less well protected against noise than ordinary individuals, and at the clinic where he worked he always warned them that they must not fire on the rifle range.

MR. W. O. LODGE, who also replied, said he was very pleased to have had the privilege of taking part in such an interesting discussion, and suggested that at some future date, after prolonged and mature consideration, and when the time was ripe, recommendations should be sent by the President and the executive body of the Section of Otology to the Minister of Health, including particularly some of the observations made by Brigadier Myles Formby and embodying some of the accumulated wisdom from some of his previous reports with regard to the recruitment of persons suffering from chronic otitis into the Services.

The other important point was that in almost all these cases there was a history of trouble dating back to infancy, and therefore he thought that the Section of Otology should, at the proper time and place, seriously consider the wisdom of notification and of making available more cots for in-patients at the only time when any treatment, operative or non-operative, and particularly non-operative, was really effective, namely in early childhood.

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## A CONTRIBUTION TO THE THEORY OF THE MECHANISM OF THE AUDITORY APPARATUS

By A. TUMARKIN (Liverpool)

To most otologists the Helmholtz theory—as amplified by Wilkinson and Gray—provides a completely adequate account of the mechanism of the auditory apparatus. The evidence in favour of it, as marshalled for instance by Hartridge in Starling's *Principles of Human Physiology*, seems to be more than convincing, and to leave no room for alternative theories. It is true that little or no support is today given to central—or telephone—theories. Nevertheless, it should be appreciated that the Helmholtz theory is not without its limitations.

### The Damping versus Selectivity Paradox

One serious difficulty is briefly as follows :

The ear is believed to be critically damped. But a resonating system if critically damped loses its characteristic frequency. (See appendix.) Thus a set of such systems, if critically damped, could not act as a harmonic analyser. (In other words, the ear apparently exhibits two incompatible properties, i.e., critical damping and high selectivity.) To evade this dilemma, Stevens and Davis abandon the Helmholtz theory and in its place they quote an analysis by Reboul (1 and 2) based on the conceptions of a propagated disturbance in a column of fluid contained in an elastic wall.

This hypothesis is supported by an imposing mathematical analysis, nevertheless, it is not difficult to discern certain serious flaws in the general argument.

It is not possible to proceed to the detailed discussion of the problem without reference to certain simple but important physical conceptions.

In order not to confuse the issue, a discussion of these has been relegated to an appendix.

We may open our enquiry by asking first whether the ear really is critically damped. Stevens and Davis (*loc. cit.* p. 413) say, "The ability of the cochlear microphonics to follow the phase-shift, without showing evidence of dying out to zero and starting up again in the new phase, means that the microphonics are generated by a mechanism which is very nearly critically damped. That the basilar membrane should be so highly damped argues strongly against the resonance-theory of hearing."

On the other hand, Hartridge (3) claims that the ear is not critically damped, and that it does show a very definite "persistence", which is

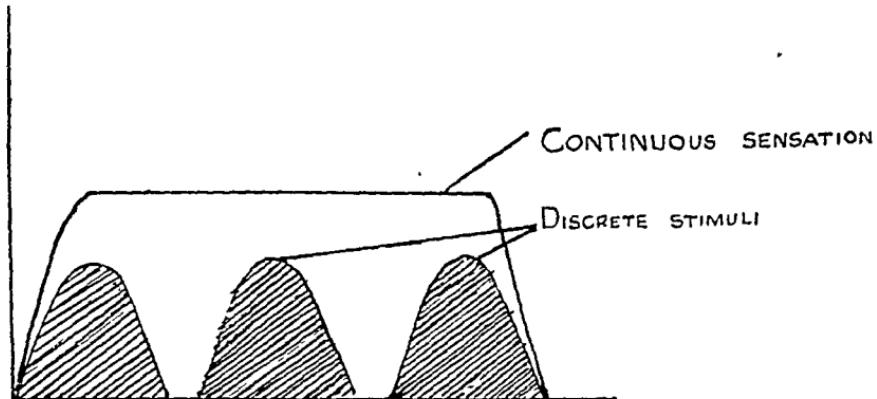


FIG. 1.

Summation of discrete stimuli to produce a continuous sensation.

proportional to its selectivity, as would be expected from any resonating system.

Many other authorities say that the overall vibration of the ear is highly, but not critically, damped. Kobrak gives a damping factor equal to about one half the value for critical damping.

Some confusion has arisen because it is not always clear how much of the ear is involved in the damping phenomena. Many experiments, for instance, have been done with a "flicker" technique. Just as a sufficiently rapid sequence of still pictures at a cinema gives the illusion of movement, so a series of short duration tones, separated by minute intervals of silence can give the illusion of a continuous tone. (Fig. 1.) It has been assumed that this demonstrates the persistence of the mechanical vibrations due to resonance. Such experiments must clearly be measuring the overall damping of both middle and inner ears. Unfortunately it has been argued that the whole rationale of these experiments

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is open to grave criticism in that it is not physically possible to stop and start a pure tone in the manner shown in Fig. 1, and that the result of trying to do so is merely to produce a more complex mixture of allied tones. This objection is valid but it is not certain that the resultant impurities would be gross enough to invalidate completely the experimental findings.

More serious objections have been raised by Bekesy (2) who measured the slowest rate of decay of a tone which would still give the sensation of instantaneous cessation. Analysis of his figures yields the surprising result that *regardless of its initial intensity*, a tone takes a fixed time to become inaudible. In the case of an 800 cycle tone, this amounted to about 0.14 sec. although the initial intensity varied between 40 db. and 100 db. It is not possible to attribute such a *constant* persistence to continued mechanical vibration because it is of the essence of vibrating mechanical systems that their vibration amplitude diminishes logarithmically, so that the time taken to come to rest will vary with the initial amplitude.

In an effort to elucidate this problem Hartridge (1 and 2) and his co-workers designed and carried out a most ingenious series of experiments based on the "phase change" beat. Consider a system of natural frequency  $f$ . vibrating in sympathy with a periodic driving force of the same frequency. At a given moment let the direction of the driving force be reversed (i.e., let its phase be altered by  $\pi$ ). System and force are now diametrically opposed instead of in harmony. Thus the system comes to rest temporarily and then gradually resumes its oscillations at the same frequency as before. Subjective experiments were first performed in which the observer listened to a pure tone the phase of which, at suitable intervals was altered by  $\pi$ . It was claimed that at each such change of phase a momentary period of silence occurred. Objective evidence was then sought by means of the Wever and Bray technique. The pure tone with periodic phase change was applied in the usual manner to the tympanic membrane of a cat and records were taken of the cochlea microphonic and of the action potentials in the brain stem. The latter showed unmistakable evidence at each phase change of some faltering in the response comparable with the periods of silence reported in the subjective tests. On the other hand, the cochlea microphonic showed no such effect. It followed the phase change accurately and faithfully. On the basis of these results Hartridge deduced that the auditory action potentials are generated by a structure possessing definite resonance—namely the basilar membrane (or rather the hair cells on the basilar membrane). In other words, objective proof has at last been provided of the truth of the Helmholtz hypothesis. On the other hand, the absence of any faltering in the cochlear microphonic response apparently indicates that this response arises in a structure

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possessing little mass and no resonance. Reissner's membrane is proposed as the most likely source.

Stevens and Davis reject this dual hypothesis and adhere to the theory that both electric phenomena arise in a common structure—the hair cells. They accept the critical damping of the microphonic as evidence that the hair cells (and so the underlying basilar fibres) are also critically damped and they advance alternative explanations for the

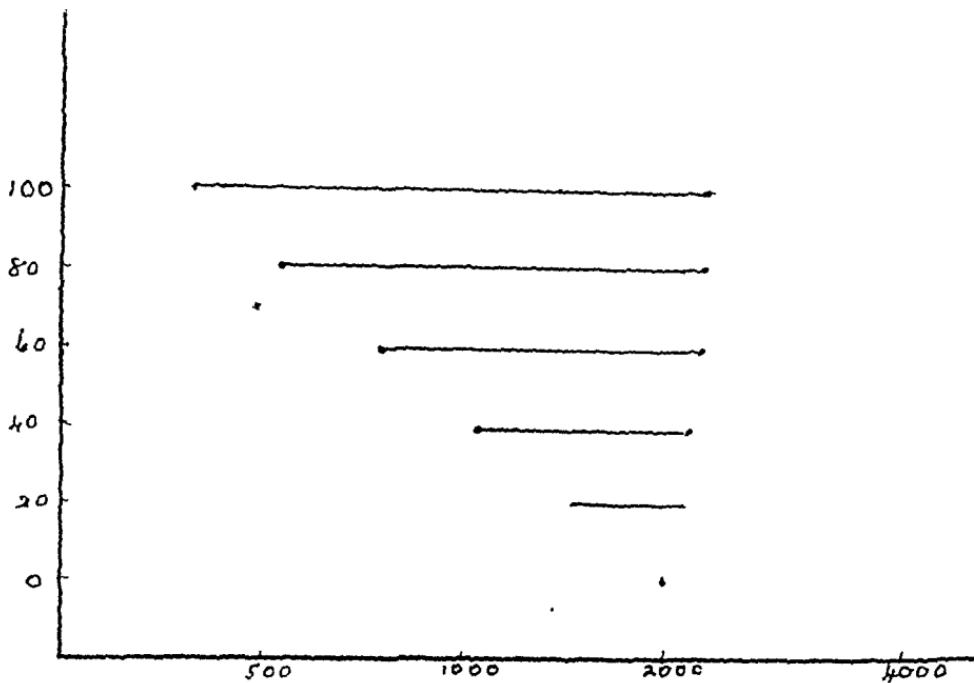


FIG. 2.

Behaviour of a single nerve fibril after Galambos and Davis. At threshold it reacts specifically to 2000 c.p.s. As intensity increases the effective band of frequencies widens. Note that the spread is mainly towards lower frequencies.

apparent faltering of the action potentials. In thus denying any resonant qualities to the basilar membrane they are led to abandon the classic Helmholtz theory and to embrace the hydrodynamic theory of Reboul. In the writer's opinion it is not necessary to accept the behaviour of the microphonic response as evidence of critical damping in the cochlea for the following reason. This response was picked up from the round window and although the stimulating tone was 1024 (and in other cases 256) it is probable that the electric response was due to those basilar fibres nearest to the round window, i.e., the high frequency fibres. It is well known from the phenomenon of masking, and indeed has been objectively proven by the work of Galambos and Davis (1) on the activity

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in single nerve fibres, that a given tone of increasing loudness stimulates an increasing length of the adjacent basilar membrane (mainly on the higher frequency side) so that at 100 db. a 300 c.p.s. tone will stimulate fibres of natural frequency from 250 to 2500. (See Fig. 2.)

If this be accepted, it would appear that in Hartridge's experiment a structure of natural frequency, say 10000 to 20000 c.p.s. was reacting to a forcing stimulus of 1024 c.p.s. Now for faithful response and to avoid resonance effects, the engineer tries to build his recording apparatus so that its parts have a natural frequency at least six times that of the frequencies to be recorded. Such a system will faithfully record without any distortion because its resonant frequencies are so remote from the frequencies to be recorded that they do not produce any significant distortion. In the same way a 10000 c.p.s. fibre might be expected to record quite faithfully the phase variations of a 1024 c.p.s. tone. It is possible, therefore, that a record of the microphonic from the apex of the cochlea might have yielded a faltering effect similar to that shown by the action potentials, because the microphonic from that region is due to fibres of low natural frequency.

To sum up, the English school maintains that the microphonic is due to a critically damped structure, i.e., the membrane of Reissner, whilst the action potentials are due to vibrations of the basilar membrane which is a truly resonating structure.

The American school accepts the evidence of critical damping, but as they believe that both electric phenomena originate from the same structure, i.e., the hair cells, they are forced to conclude that the basilar membrane is itself critically damped; thus abandoning the standard Helmholtz hypothesis.

In the writer's opinion, the evidence of critical damping is not as conclusive as appears at first sight, and in any case need not be accepted as indicative of the behaviour of the basilar membrane. There is, in fact, no good reason for abandoning the classical theory.

Despite this conclusion, the organ of Corti must be heavily (though not critically) damped. It is not possible, for instance, to see how the complex sounds of speech could be analysed without heavy damping. And so we return to our dilemma, namely, how are we to reconcile such heavy damping with the amazing selectivity of the ear.

### A Possible Solution to the Paradox

The following analysis may throw some light on this obscure problem :

Consider a frictionless pendulum oscillating as a result of a single sharp blow. Such a system would never come to rest, simply because it can never get rid of its energy. All that happens is a cyclic change of Kinetic to Potential energy and back again. The introduction of damping by friction will gradually bring the pendulum to rest because the energy

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becomes transformed into heat by an irreversible process, i.e., the heat does not, in its turn, become transformed into Kinetic or Potential energy.

Now in speaking of damping we tend to think solely in terms of friction, and so we overlook the simple fact that any other process which can irreversibly extract energy from a vibrating system will damp it. Electro-magnetic induction and high frequency radiation are typical examples.

Let us now envisage the sequence of events when a pure tone energizes the ear for a period and then stops. To simplify matters let us use a tone of 1500 c.p.s. At this frequency the overall impedance of the ear is almost the same as that of free air. Because of this impedance matching, energy passes freely from the air into the ear. The sound wave in air is the driving force. The drum and middle-ear structures are in *forced* vibration. We do not know the natural frequency of this middle-ear system, but let us assume a figure of 1000 c.p.s.<sup>1</sup>. In the inner ear, the basilar fibre subserving 1500 c.p.s. is resonating whilst other fibres, more especially those of higher frequency are in forced vibration. When the sound ceases the middle and inner-ear systems have a considerable store of Kinetic and Potential energy. We look for a method whereby this energy can be rapidly dissipated without interfering with the sensitivity of the ear. The writer's suggestion is that the same impedance matching which enables the ear to absorb energy so readily from the air equally enables it to radiate energy back into the air. Thus even in the extreme case of a completely frictionless inner ear, giving ideal selectivity, we expect the residual energy to be so rapidly dissipated as to approach critical damping. The degree of damping depends on the impedance matching between ear and air for the frequency under consideration. We know from the work of Geffcken and of Troger that in general the overall impedance does not exceed 200 (air=40 water=155,000) so that this reverse radiation of energy, although not quite so efficient as at 1500 c.p.s. will still be more than adequate to provide the damping we require. A further consequence of this hypothesis follows. It has been shown that with a forcing tone of 1500 c.p.s. only the basilar fibre subserving that tone is in resonance. All the rest of the basilar fibres (if they are moving at all) and the middle-ear structures, are in *forced* vibration. When the forcing tone ceases, all these structures tend to revert to their natural frequencies. Thus the picture of a basilar membrane with a peak displacement at 1500 is immediately replaced by a confused picture in which the peaks, if there are any, will be determined by the natural periods of the various structures concerned. And this confused picture is itself rapidly obliterated by the reverse radiation of energy described above. It is easy to see how such a chain of events would immediately abolish the peak at 1500 and so give rise to the sensation of an instantaneous cessation of sound. And yet, as shown above,

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the mechanical action is quite compatible with the highest degree of selectivity.

There is nothing unusual in this sequence of events. It is exactly what occurs whenever a sound is produced in an enclosed space. In accordance with its dimensions, the space will possess certain resonant frequencies, i.e., modes of free vibration of the contained air. Whilst the source is sounding, the vibrations are forced and correspond to the frequency of the source. When the source stops, the residual energy throws the air into free vibrations at the resonant frequencies. It is these which account for the reverberation which is so important in the design of lecture theatres and auditoria.

## The Middle-Ear Mechanism is Pressure Driven

This hypothesis clearly attributes a most important function to the middle-ear structures. It is well recognized that the design of the middle-ear apparatus embodies a lever system which must have some impedance

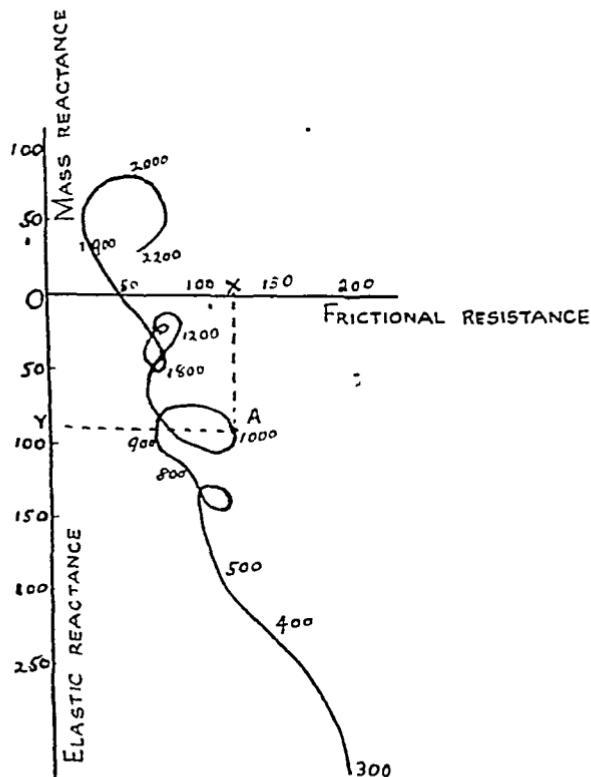


FIG. 3.  
Impedance diagram of the Ear.  
(after Gefick.)

matching function. It now appears that this matching is almost as important in reverse as in forward gear. If it is destroyed, the patient becomes deaf because his inner ear cannot absorb the energy offered it by the sound wave. But more than that, such energy as does enter the inner ear is trapped. The mechanism for its re-radiation being lost, it can only be dissipated by local frictional effects. Thus, superadded on the actual deafness is a diminished intelligibility due to inadequate damping. This assumes, of course, that the frictional damping inside the cochlea is small, and it is not difficult to find confirmatory evidence for this assumption. Fig. 3. is extracted from Geffcken's work. To determine the impedance at any frequency, measure the distance from the origin to the corresponding point on the curve. Thus at 1000 c.p.s. the required value is given by the length of OA. This can be divided into

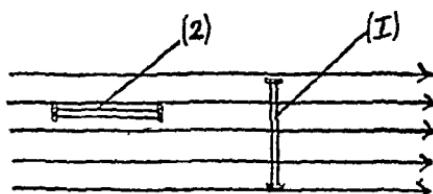


FIG. 4.  
Velocity microphones in a plane sound wave.

a real part OX and an "imaginary" part OY. The former gives a measure of the frictional resistance, the latter represents the mass and elasticity reactance. It will be seen that in moving along the graph from 300 c.p.s. to 1900 c.p.s. the frictional resistance drops from about 200 to about 25. This is what we should expect seeing that at low tones a long column of fluid is oscillating, whereas at higher tones only a short column oscillates. These figures are overall and so include the middle-ear structures as well. Even so, they are remarkably low, and it seems reasonable to claim that the part played by frictional damping in the cochlea is comparatively minor. Indirect confirmation can be obtained from a consideration of the general behaviour of the ear. We first note that friction is proportional to velocity, and so the amount of energy dissipated in a system will depend on how mobile its moving parts are. Now detector systems can be broadly divided into velocity driven and pressure driven types. A ribbon microphone, for instance, consists of a strip of pleated aluminium foil, so limp, light and loosely mounted that it moves in sympathy with the actual movement of the air particles in a sound wave. Such an instrument is highly directional. In Fig. 4 two such microphones are placed in a plane longitudinal sound wave. Instrument (1) is in an optimum position as its diaphragm will undergo maximum displacement in sympathy with the movements of the air

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particles. Instrument (2) is in minimum position and will record no sound. By contrast, a pressure driven instrument, such as the ordinary crystal microphone, will record equally well at any angle because the pressure changes in a sound wave are the same in all directions. (Fig. 5.) We may determine which of these types the human ear resembles by

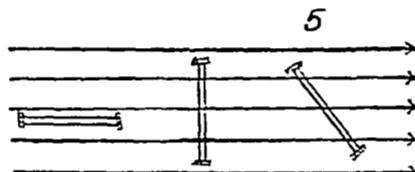


FIG. 5.  
Pressure microphones in a plane sound wave.

examining their behaviour in a standing wave. A standing wave exhibits a series of nodes and antinodes, just as a vibrating string does. At the antinodes, velocity and displacement amplitudes are maximal, whilst pressure changes are zero. At the nodes the converse is true. Thus a velocity driven instrument would react well at an antinode and badly at a node. The pressure driven instrument acts in a reverse manner. Now it is well known and easily demonstrated that in a standing wave the human ear detects sounds at a node and *not* at an antinode, i.e., it is pressure driven. This indeed is obvious when we remember that the ear is equally sensitive to sounds whatever their direction\*. Thus we may say that the ear is not designed to undergo wide excursions when in action. Rather should we visualize it as being held very tense so that pressure changes are transmitted with minimal displacement. In such a system frictional damping is reduced to a minimum.

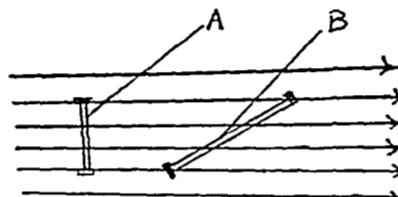


FIG. 6.

Obliquity of the tympanic membrane gives a greater effective surface. The efficiency per unit area is not diminished by this obliquity because the drum is pressure driven.

### The Obliquity of the Drum

It is interesting to note that this argument gives a possible explanation for the obliquity of the drum. In Fig. 6 A and B are two velocity driven

\* This is not strictly accurate, but the minor differences which occur, especially at high frequencies, are due to the geometrical contours of the pinna and skull and not to the intrinsic characteristics of the auditory apparatus.

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microphones. Their areas are respectively perpendicular and oblique sections of the external auditory canals. A is obviously more advantageously placed than B. On the other hand, owing to its obliquity the diaphragm of B is larger than that of A. Thus there would be little difference in the performance of two such instruments. Suppose, however, that the instruments are pressure driven : As shown above, a given area of such a microphone will act just as efficiently whatever its angle and since the diaphragm of B is greater than that of A it will be proportionately more efficient. In the human ear this effect is further augmented because the obliquity is in three dimensions instead of in two.

## The Inner Ear is Velocity Driven

These statements of course apply essentially to the drum ossicle mechanism and we must be very careful in attempting to carry over the argument to the cochlea. In fact it would appear that the basilar membrane is velocity driven. We have concluded that the vibrations of the tympanic membrane have a very limited amplitude and the lever ratio of the ossicles implies that the excursions of the stapes are even smaller. Now let us consider the cochlea as an independent system of which the stapes is the source of energy. As before we consider a sound of 1500 c.p.s. Maximum pressure will occur in the immediate vicinity of the stapes and the basilar membrane will tend to yield slightly at that spot. But those fibres have a natural frequency of 30000 and so they will present an almost rigid front. Thus the pressure wave passes on diminishing in intensity, very slowly at first, but more rapidly further on as it traverses fibres which are progressively more and more in sympathy with its frequency. When it reaches the 1500 c.p.s. fibre it falls to zero because practically no resistance is offered to it. It is literally short circuited, and so practically no pressure effect passes on to fibres beyond of lower frequency. Fig. 7 shows the sort of changes envisaged and it\* is clear that the resonating fibre is a region of maximal velocity and displacement and of maximal pressure gradient†. This short circuiting of the pressure wave at the resonating fibre means that fibres of lower

\* I have ignored possible variations at the harmonic points.

† We should really distinguish between a linear pressure gradient, i.e.,  $\frac{dp}{dx}$  the pressure drop per m.m. along the membrane, and a temporal pressure gradient, i.e.,  $\frac{dp}{dt}$  the rapidity at which the pressure is changing *at a given spot*. At the stapes the pressure changes in one cycle are greater than anywhere else in the cochlea. Thus the stapes show the greatest pressure gradient in time. On the other hand, at any given moment the pressure drop between the stapes and a point 1 mm. further on is trivial. Thus the linear gradient at the stapes is minimal. At the resonant peak the linear gradient is maximal, i.e., within a couple of mm. it has collapsed almost to zero. Beyond the resonant peak—except at higher intensities—little or no change occurs whether measured from point to point on the membrane or from moment to moment at any given point.

## Mechanism of the Auditory Apparatus

frequency are hardly affected at all. There is ample experimental evidence to support this. For instance, it is well known that a low tone will mask high tones, but a high tone will not mask low tones. Even

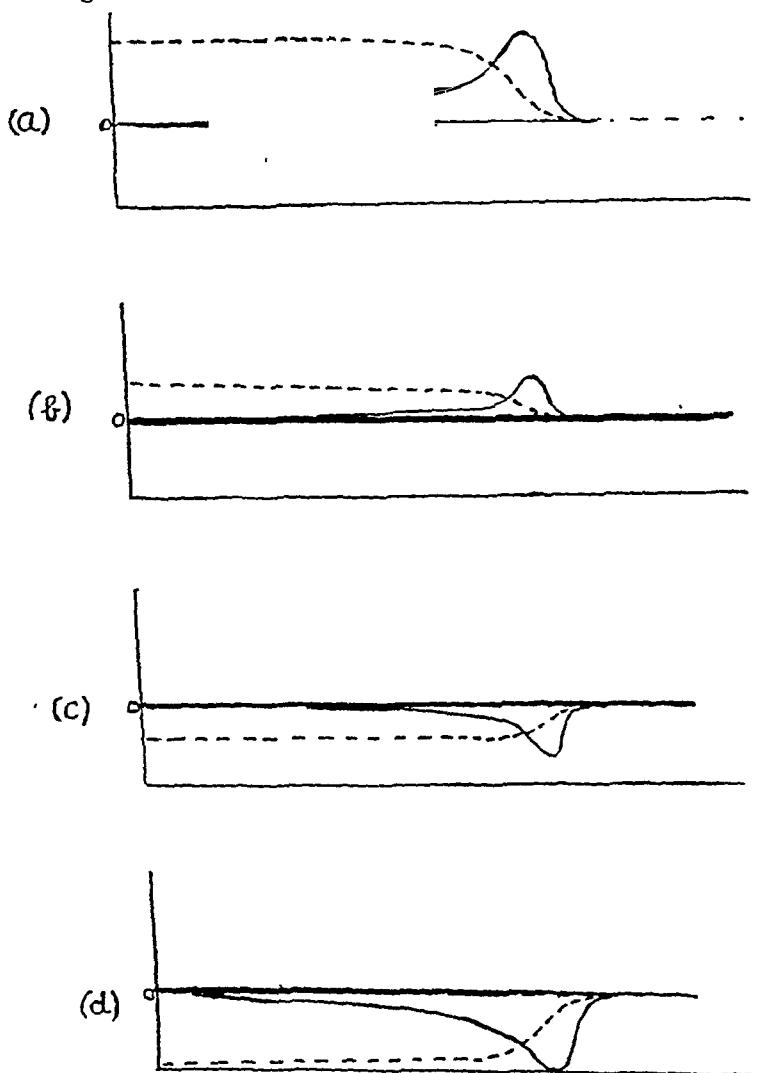


FIG. 7.

Displacement of basilar membrane (continuous lines) according to classic theory. Pressure gradients (dotted lines) according to writer's theory.

more direct proof, is available from the work of Galambos and Davis. These workers isolated the response of a single nerve fibre. They found that with minimal intensities the response was highly specific, being only evoked by a narrow band of frequencies. (Fig. 2.) In the experiment

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quoted this was 2000 c.p.s. If stronger sounds were used it was possible to throw the fibre into action with a much broader band of frequencies so that at 100 db. any frequency from 250 to 2500 c.p.s. could stimulate it. These figures 250 to 2500 should be compared. We may assume that the natural frequency of the basilar fibre subserving this particular nerve fibril was 2000 c.p.s. Consider now a tone of 250 c.p.s. We know that at 100 db. it reaches down\* the basilar membrane as far as the 2000 fibre—a "distance" of 3 octaves. On the other hand a tone of 2500 c.p.s. can only reach up the membrane to the same point, i.e., a distance of less than half an octave. Thus the evidence clearly indicates that at feeble intensities a pure tone stimulates a very limited area of the basilar membrane. As the intensity increases this area increases and at high intensities it may involve a large fraction of the total membrane. *But* the spread is almost entirely confined to the regions of higher frequency than the stimulating tone.

### On the function of the Intratympanic Muscles

The above discussion leads us to a conception of the action of the intratympanic muscles which is different from the standard view. If it be agreed that the ear is pressure driven it is natural to look for a subsidiary mechanism which will hold it tense whilst in action and allow it to relax during periods of silence. Furthermore, the most efficient transfer of energy, whether from air to endolymph, or vice versa, will occur when the ossicular chain is mechanically close coupled, i.e., when there is no slackness in the joints. We are thus led to regard the muscles as essential for the efficient action of the ear as a whole and we would expect them to come into action much as an animal "pricks its ears", i.e., as an act of attention to faint sounds.

Standard theory is that the muscles act as a defence against loud noise: This is a curiously anthropocentric thesis and we shall do well to consider its implications. First we must distinguish sharply between continuous loud noise such as occurs in a boilermaker's shop, and the sharp impulsive noise of an explosion, or thunderclap. Continuous loud noise is a product of civilization. It is almost unknown in the animal world. Now the stapedius is well developed in saurians, whilst the tensor tympani makes its first appearance in mammals. Thus the muscles appeared millions of years before the development of man and of man-made noise. Whilst admitting that arguments as to purpose cannot be conclusive, it is legitimate to ask how such a mechanism can have developed. What environmental pressure can have evoked it? What survival value can it have had during the millions of years which preceded the advent of man? It may be argued, however, that *impulsive* loud

\* "Down" here means from apex to basal coil. Unfortunately this goes *up* the scale of frequencies.

## Mechanism of the Auditory Apparatus

Noises such as claps of thunder are comparatively common in nature. This must be admitted, but let us enquire what defence the musculature can provide against such a trauma. The reflex contraction of the tensor tympani has been investigated most carefully and has been shown to have a latent period of about  $0.014$  sec. whilst maximum tension is not reached for more than  $100$  m.sec. The evoking stimulus for this reflex is the actual arrival of the sound wave. Thus for  $0.014$  sec. after the onset of the trauma, the defence mechanism is inactive. Surely such a defensive reaction would be of little or no value against a sharp pulse pressure. It might be thought that  $14$  milliseconds is a very short interval, but the investigations of Steudel and of Burck *et alia* shows that it is more than adequate for the damage to be done. These workers experimented with noises and clicks of very short duration. They found that for extremely short clicks, i.e., less than  $1$  m.sec. the loudness depended on the duration. But for anything more than  $1$  m.sec. mere prolongation had no effect on loudness. In other words, an impulsive noise is wreaking its full effect on the ear within  $1$  m.sec. of arrival at the cochlea.

To sum up, it seems that the intratympanic muscles can be of little defence value against impulsive noise. A possible function in continuous noise might be conceded but such a very recent phenomenon as continuous loud noise cannot explain a mechanism which is coeval with the mammal. We naturally turn to observational data for a clarification of this curious paradox, but unfortunately the available evidence is quite inconclusive. Much work has been done on the acoustic reflex, i.e., the reflex contractions of the muscles. It has been shown for instance that in rabbits under urethane anaesthesia it cannot be evoked by a sound less than  $40$  db. above human threshold. It is not easy to deduce anything from this. We might just as well investigate the action of the quadriceps—by studying the kneejerks under general anaesthesia. It is true that the acoustic reflex is not a true tendon reflex, since it persists even after the tendon is divided. Nevertheless, if the muscle did subserve a function of attention as outlined above it is unlikely to be revealed by investigations of the acoustic reflex.

Two apparently unrelated facts can be co-opted in support of either theory. First, the intratympanic muscles of the guinea pig (and possibly all other animals) are in continuous rhythmic contraction and relaxation. Secondly, histological examination (Grandson Byrne) reveals both voluntary and involuntary muscle fibres. It is tempting to argue that the involuntary fibres are responsible for the rhythmic contractions and that the voluntary fibres only come into action in a crisis. Such an arrangement might give an animal some protection against loud noise, but it would equally well serve an animal constantly on the alert for the faint sounds of its prey or its natural enemies in a hostile environment.

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Of the comparatively recent work on this problem, that of Hallpike and Rawdon Smith (1 and 2) may be quoted. They used the Wever and Bray technique and were able to show a conspicuous decrease in the amplitude of the cochlea microphonic as a result of the acoustic reflex. They concluded that since the reflex contractions occur in response to sounds of fairly high intensity, the theory of their action as increasing the sensitivity of the ear as in listening, seems *a priori* unlikely. On the other hand, they also state that "the short duration and small degree of this damping do not wholly favour the protective theory of the muscles' action".

Wiggers used a similar technique to observe the effect on the microphonic of the above mentioned rhythmic contractions in the lightly anaesthetized guinea-pig. Although he found a considerable diminution at very low tones (circa 100), the effect diminished rapidly with increasing frequency. At 1000 it was absent and indeed about 1300 an amplification was noted. Above 2000 no effect was noted. Now theory suggests, and clinical findings amply confirm, that the main impact of blast or loud noise is on the basal coil—the frequencies above 4000 c.p.s. We have already seen that the acoustic reflex arrives too late to help, and we now find that even if it were in time its action would be in the wrong place.

To sum up: We have apparently to choose between the "attention" and the "protection" theory. Authorities in general seem to have decided for the latter and against the former. In the writer's opinion there is no theoretical basis for that decision, and the experimental evidence provides no substantial support for it. Furthermore, such work as has been done has not been such as would demonstrate an "attention" function. We are really in need of a technique for examining the behaviour of these muscles in a conscious subject during the course of listening to faint sounds. Finally we may note that an "attention" theory is not necessarily incompatible with a modified protection theory. Let us visualize the ear of a sleeping animal. The aural muscles (both intrinsic and extrinsic) are relaxed, the pars tensa is limp, the ossicles disengaged. For simplicity we may ignore the possibility of rhythmic involuntary contractions. In response to a slight noise the animal pricks its ears. The intratympanic muscles contract and as a result the whole middle-ear mechanism tightens up and becomes a pressure driven sound detector. Suppose now the sound increases steadily to 120 db. over the threshold. This is an enormous range. One doubts whether any man made machine could cope with it, even with the aid of shunts. It means that the excursions of the moving parts would be multiplied by  $10^6$ . Is this feasible? According to Wilska, at threshold the drum excursion is less than  $10^{-9}$  cm. which is much less than the diameter of a hydrogen molecule. Even if this were multiplied by  $10^6$

## Mechanism of the Auditory Apparatus

it only implies an excursion of one-hundredth of a millimetre. This would certainly throw no strain on the drum. On the other hand, we must remember that the corresponding basilar fibres are in resonance, so that their excursions are proportionately much larger than those of the drum. In deference to that possibility it may be conceded that some protection is desirable. It will be shown later that the intrinsic structure of the cochlea itself may provide the necessary mechanism, but we need not deny that the muscles may help by steadily increasing the tension of the drum. Such an action is not incompatible with the "attention" function which, in the writer's opinion, should be regarded as the main purpose of the muscles.

If the above hypothesis be true, it should be possible some day to demonstrate that the action of the muscles consists of a sharp contraction in response to an act of attention followed by a steady (or possibly step-like) increase in tone in response to increasing stimulus.

### Pressure and Displacement Curves in the Cochlea

We may now return to a consideration of what goes on inside the cochlea. We have already arrived at the conception embodied in Fig. 7a which gives a diagrammatic representation of the pressure and displacement changes. It is an instantaneous picture of the state of affairs just when the pressure is maximal and the following three diagrams complete the picture for one half cycle.\* An alternative solution has been offered by Harvey Fletcher. He pictures a whip like wave motion as shown in Fig. 9.

In the writer's opinion this is far too symmetrical. It indicates displacement changes beyond the resonant peak (i.e., towards the helicotrema) which are equal to those proximal to it (i.e., towards the stapes). The evidence already quoted seems to show conclusively that the effective stimulus (whether it be pressure or displacement) collapses just beyond the resonant peak, so that little or no effect is transmitted beyond it to the fibres of lower frequency.

We may include here Reboul's diagram (Fig. 8) of the behaviour of the cochlea. He does not actually discuss the changes which occur in a complete cycle, but contents himself with showing that the point of peak displacement will move steadily down the basilar membrane towards the stapes as the frequency rises. In this diagram continuous lines represent the actual displacement of the basilar membrane. The dotted lines represent the calculated pressure changes. Reboul suggests that the pressure changes may be the determining factor in the production of the

\* This takes no note of a possible phase angle between pressure and displacement.

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sensation rather than the displacement. He argues that the microphonic is due to capacitative changes across the endolymph and that these changes are caused by the pressure gradient. He maintains that the

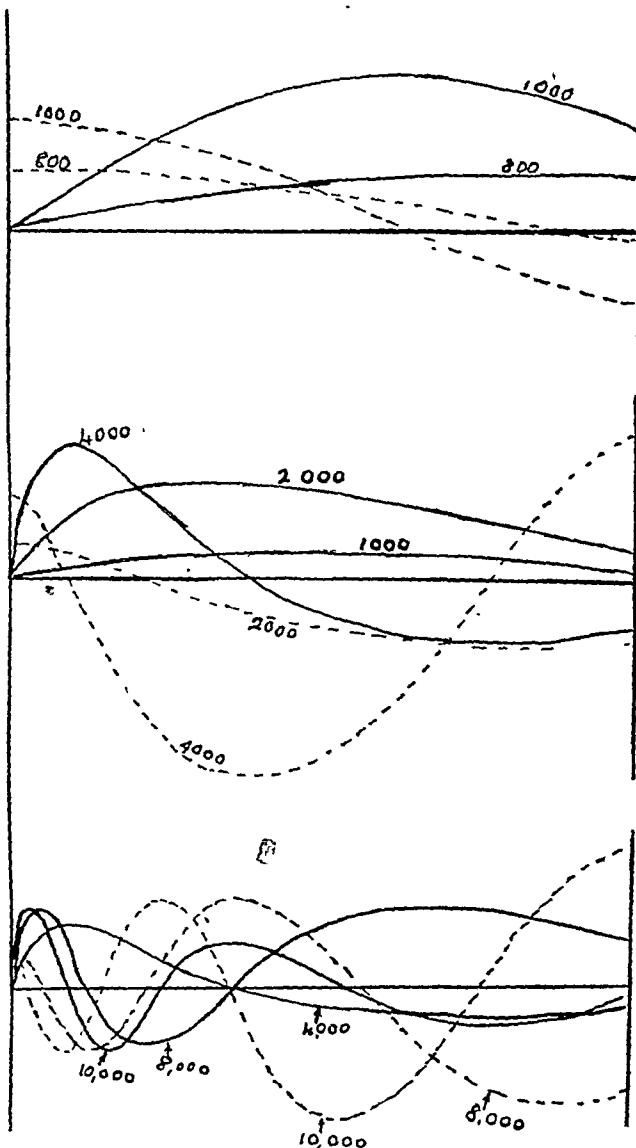


FIG. 8.

five forms in the cochlea after Reboul. Thick lines indicate actual displacement.  
Dotted lines indicate pressure changes.

# Mechanism of the Auditory Apparatus

microphonic actually provokes the auditory sensation and thus claims that the Helmholtz theory cannot fit the case \* †.

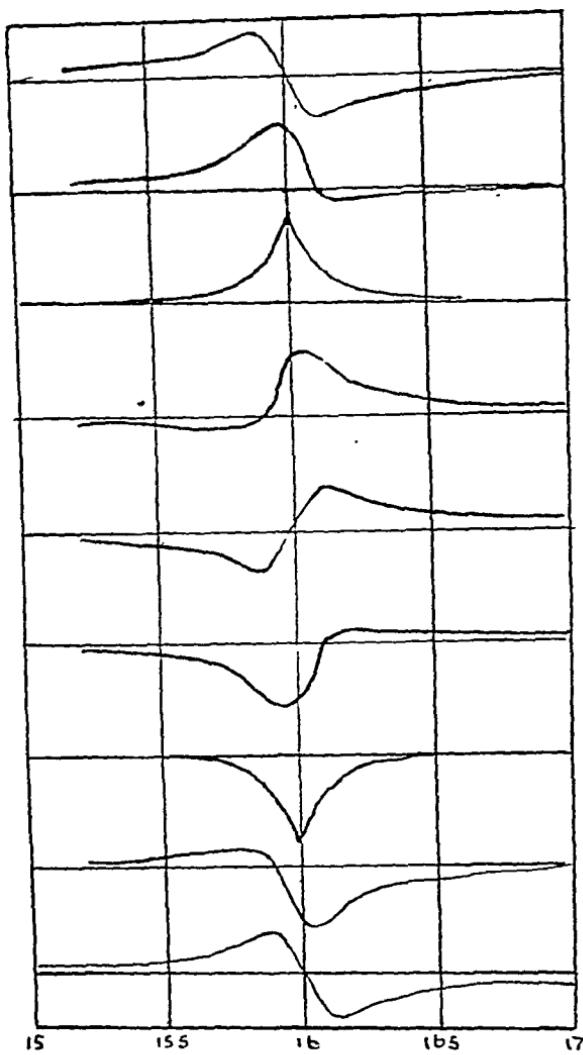


FIG. 9.

Wave forms in the cochlea after Fletcher, showing displacement of basilar membrane at intervals of  $\frac{1}{8}$ th of a cycle. Note the symmetry indicating changes beyond the resonant peak equal to those proximal to it.

\* "Ces différences de potentiel produiront sur les fibres nerveuses correspondantes une impulsion qui sera transmise au cerveau, la résultante des impulsions venant de l'ensemble des points de la membrane basilaire donnera la sensation de son avec ses divers caractères."

† "Si on admet une relation entre la réponse électrique et les phénomènes de l'audition, on arrive à l'importante conclusion que les oscillations de la membrane basilaire ne sont pas le phénomène essentiel."

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It does not seem necessary to concede any of the points in this argument. To begin with, it is quite easy to envisage capacitative changes at the displacement peaks which could evoke potential changes just as well as those Reboul describes at the pressure gradient. Indeed it is such changes due to distortion of Reissner's membrane which are considered by Hartridge to be the cause of the microphonic. Secondly, the possibility that the cochlear microphonic is the direct cause of the functional reaction has been considered and rejected. Authoritative opinion regards it as an epiphénoménon and not a direct link in the chain from sound wave to tonal sensation. All things considered, therefore, we cannot concede that Reboul's attack on the Helmholtz theory carries real weight.

## Modes of Damping

The dissipation of energy inside the cochlea has in the past been considered as entirely due to frictional losses. In order to explain the heavy damping, it has been necessary to assume that these frictional losses were correspondingly great. We are relieved of this necessity if we accept the theory of reversed radiation damping. We may, therefore, argue that frictional losses are possibly quite small, and this fits in with the pressure controlled behaviour of the middle ear. According to this conception the movements of the drum, and a fortiori of the stapes are minimal. Thus the translatory movements of the perilymph are minimal also, and as these determine the magnitude of the frictional loss we may conclude that those in their turn are not large.

Energy must also be provided for two other purposes. First the cochlear microphonic. Whether we regard this as due to vibrations in Reissner's membrane, or in the basilar membrane, its energy must derive ultimately from the original sound wave. It is tempting to try and assess this effect by determining the power in the microphonic in response to a given intensity of sound, but care must be exercised in basing deductions on these calculations. The microphonics are picked up by closing a circuit between say the round window and some neutral point. It is possible that in the body the circuit is closed by a quite different reactance in which the power losses are quite different.

Energy is also required for the stimulation of the auditory nerve fibrils. This has nothing to do with the action currents which are provided by the fibrils themselves. It is well known that a stimulus—whether electric, mechanical or chemical, must reach a certain minimum level before it can evoke the all or nothing response of a nerve fibril. This must be included in the damping factor of the inner ear and is indeed the useful fraction from the functional point of view. All other types of damping, whether frictional, microphonic, or reverse radiation serve no functional purpose. When we reflect on the amazing sensitivity of the

## Mechanism of the Auditory Apparatus

ear we must come to the conclusion that at threshold there is so little power available that most of it must be absorbed in functional or useful damping. At higher energy levels no doubt other factors come in as outlined above. In this respect one final point may be raised. It has been quite conclusively shown that action potentials are only evoked in the half cycle produced by outward movement of the stapes, i.e., when the hair cells are being compressed between the upward moving basilar membrane and the overlying tectorial membrane. The opposite half cycle has no such effect. Is it possible that functional damping only

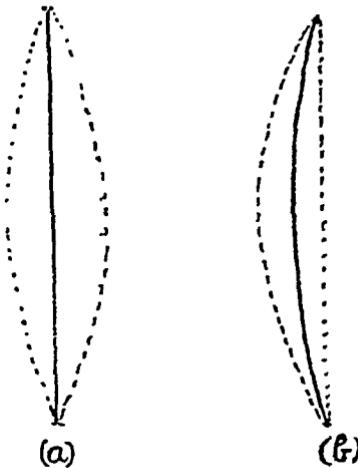


FIG. 10.

Vibrating string.

- (a) With symmetric damping.
- (b) With asymmetric damping.

takes place in the first half cycle? If this were the case, it would lead to a curious state of affairs. Consider a string A O B (Fig. 10a) vibrating in the ordinary symmetric manner from A X B to A Y B about a straight line A O B. Now suppose that movements from left to right are more heavily damped than those from right to left. It seems reasonable to assume that the string would be affected as in Fig. 10b. In other words, we might regard it as vibrating symmetrically about a curved position A O B. If we apply this conception to the basilar membrane we are led to visualize it as distorted up towards the scala vestibuli all the time the tone is sounding. Of course the vibrations are superadded on this basic distortion and are probably the determining factor in evoking the action potentials. When the tone ceases, however, the basilar membrane would rapidly resume its normal position and it is conceivable that this terminal collapse would help to promote that rapid cessation of sensation which has concerned us so much throughout this article.

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## Defence Against Loud Noise

It has already been suggested that the design of the cochlea may include some provision against loud noise. As usual consider a 1500 c.p.s. tone. Fig. 11a represents an ear without a helicotrema and with a rigid basilar membrane except at the fibre O with a natural frequency of 1500 c.p.s. In such a system the full brunt of the pressure changes falls on O, and with increasing intensity it must eventually burst. Now suppose that a hole is made at P. (Fig. 11b). This offers even less resistance to the fluid flow than O and as it encounters the pressure wave before O does, the latter would hardly register any effect at all. If, however, P is closed by a fibre of say 5000 c.p.s. natural frequency, it would offer more resistance than O (although much less than the original

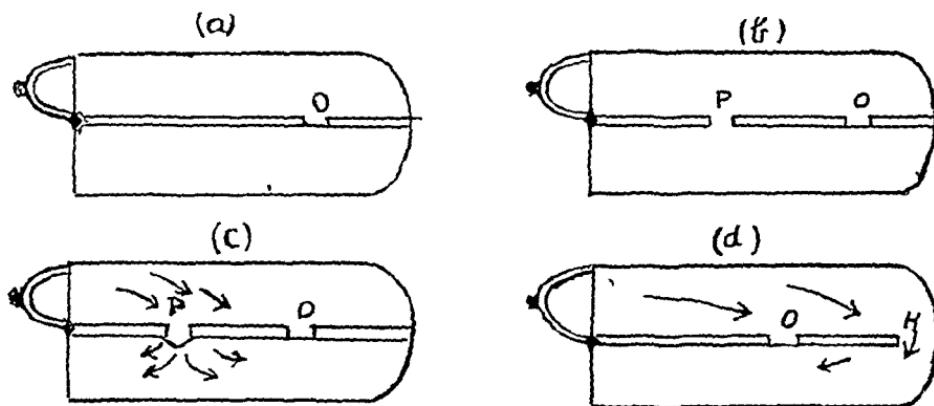


FIG. 11.

The intrinsic defence of the cochlea against excessive pressure.

rigid membrane). In that case P falls into forced vibrations (at 1500 c.p.s.) which are of smaller amplitude than those at O, but precede it by a certain phase angle depending on various factors including the distance O P. Fig. 11c shows the state of affairs when the pressure wave has passed P but has not yet reached O. P bulges into the scala tympani so that a pressure wave passes not only down towards the fenestra rotunda but also up towards the under side of O. Furthermore, it will reach O just in time to support it against the original wave in the scala vestibuli.

Lastly, consider the effect of a hole at H. We have already seen that a hole proximal to O would probably completely abolish its vibrations. Not so the helicotrema. O encounters the pressure wave before H and, reacts adequately, so that normally the pressure wave does not over-ride it. If, however, the pressure changes become too violent, O will begin to offer increasing reactance and so as in Fig. 11d pressure effects will spread up and via H into the scala tympani so as to support O once more. It might be thought that the wave through H would be too late to support

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O, but it must be realized that the displacement at O will lag in phase on the pressure, whereas the helicotrema opposes no phase delay at all so that although this subsidiary, or overflow, wave has a longer path to travel, it probably reaches the under surface of O before the primary wave has reached its maximum.

Summing these discrete features, we have reason to believe that the design of the cochlea involves a mechanism for minimizing the effects of excessive pressure. That is to say, whenever the pressure in the scala vestibuli threatens to become dangerous, overflow sluices come into action which not only drain off excess pressure, but support the resonating fibres against the pressure of the primary wave. A consideration of this protective mechanism reveals that it will be much less efficient when the forcing tone has a high frequency than when it has a low frequency. In the former case there is comparatively little basilar membrane proximal to the resonating fibre through which protective waves can travel and also the helicotrema wave has so far to travel that it may arrive too late. Thus the theory confirms the clinical findings that the deleterious effect of excessive pressure on the ear is most pronounced in the basal coil.

### Assessment of Loudness

We have so far merely considered the longitudinal contours of the vibrating basilar membrane. An interesting point emerges if we consider its transverse contours. There is reason to believe that under

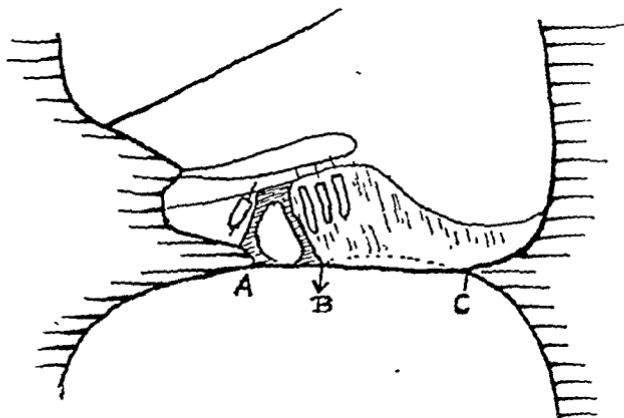


FIG. 12.

Transverse vibration of basilar membrane at low intensities takes place about B C and so only stimulates the outer hair cells. At higher intensities vibration occurs about A C and also involves the inner cell.

moderate forcing the main movement takes place about B and C as fixed points (Fig. 12), because the rods of Corti are sufficiently rigid to hold the base A immovable. Thus, up to say 40 db. the auditory

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sensation is due to stimulation of the *outer* hair cells. As the sound pressure increases, however, the rods of Corti begin to yield slightly and the vibration takes place with two degrees of freedom about A and C with B as an intermediate point. At this stage, the inner hair cell begins to react. Indirect confirmation of this hypothesis is obtained from histological sections which demonstrate quite clearly that the main damage resulting from loud noise is located in the outer cells. Such an action partakes of the nature of a shunt. It is reasonable to argue that the brain would interpret impulses from inner cells as indicative of much greater intensity than those from outer cells. A point might well be reached at which the "output" of the outer cells could no longer increase, and for any great intensity, the sensation of loudness would be determined almost entirely by the output of the inner cell.

This hypothesis provides a plausible explanation for the "recruitment of loudness" phenomenon described by Fowler. He has pointed out that in nerve deafness, the reaction to a gradually increasing sound is quite typical. As soon as the patient hears the sound he reports that it is quite loud. There is not the gradual increase of loudness such as occurs in normal hearing or in middle-ear deafness. If we assume that in these patients the outer cells have deteriorated, then the threshold would be determined by the inner cells, and we have seen that the brain will attribute to the threshold output of the inner cells a loudness value of 30 or 40 db.

## Variation of Pitch with Intensity

A final consequence of this hypothesis is that with increasing intensity the pitch of a tone will appear to alter. The elasticity and mass of the structures based on A C must differ from those based on B C, with corresponding effect on the natural frequency. It seems reasonable to assume that the frequency of A C will be lower than that of B C. On the other hand, as intensity rises, the excessive bowing of the membrane tends to increase its tension and so to increase its natural frequency. There are thus two opposing tendencies at work and we must expect their resultant effect to vary at different points on the membrane. This is exactly what happens. (Stevens.) At frequencies about 2000 the effects annul and there is no change of pitch with intensity. At higher frequencies the first effect predominates and pitch appears to rise whilst at lower frequencies the opposite occurs.

## Clinical Deductions

It is generally agreed that the main function of the middle ear is to match the impedance of the air and of the inner ear. For the optimum transference of sound energy from air to water, or vice versa, a transformer ratio of 60 is necessary, and there is reason to believe that the

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middle ear provides such a lever action. The drum area is about 30 times that of the fenestra ovalis and the disparity in the effective lengths of malleus and incus must contribute as well. Most authorities estimate the effective length of the malleus as about 50% greater than that of the incus. It is not easy to evaluate the significance of this ratio, especially as the long process of the incus comes directly off the incudo malleolar articulation, whereas the handle of the malleus is prolonged by a slender neck. Thus as viewed clinically it almost appears as if the axis of rotation passes through the incudo stapedial joint. This, of course, would very much increase the lever ratio.

Unfortunately the exact modes of vibration of the ossicles have not been completely elucidated and the whole problem becomes even more obscure when on further consideration we realize that an impedance

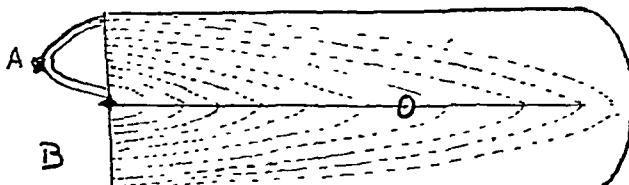


FIG. 13.  
Streamlines in the cochlea.

matching mechanism may not be so necessary after all. It is true that in order that a sound wave *as such* may pass from air to water, a transformer ratio of about 60 is necessary. But the fluid movements in the cochlea are *not sound waves*, they are mass movements of finite columns of fluid. In a sound wave there is merely a cyclic alternation of compression and rarefaction propagated through a medium without any significant movement of the medium itself. Thus the impedance of an oscillating finite mass of fluid has no relation to the impedance presented by an infinite mass of water to an incident sound wave.

We are led, therefore, to speculate as to the mechanical impedance of the cochlea when considered as a small mass of fluid undergoing translatory movements without any significant compressions. We may subdivide the total mass into a series of laminae of which one (say A O B) is in resonance. (Fig. 13.) And, except for very high intensities, the main movement of fluid will take place along A O B. But since A O B is in resonance, its impedance is purely frictional, and as we have already decided that frictional resistance in the cochlea is very low we must conclude that its impedance is also low. It might be thought that the higher impedances of the non-resonant laminae of fluid would increase the overall impedance of the cochlea, but since they are in parallel,

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their influence is not great except at higher intensities. If, then, the impedance of the cochlea is low, what need is there for an elaborate matching device? It should be possible for sound energy in air directly to activate the perilymph. As usual we turn to experimental evidence. Unfortunately we are faced once more with conflicting opinions. According to Bekesy (1) and others, loss of the middle-ear apparatus results in a deafness of up to 60db. although occasional cases only show a loss of 30 db. These estimates are based on clinical evidence and also on the effect on the microphonic of dividing the incudo stapedial joint. How then are we to explain the results of the fenestration operation? It is hardly likely that the artificial fenestra is as efficient as the normal fenestra ovale, and yet many of these patients apparently show a hearing loss of less than 30 db. We may note that even in the direct transference of true sound waves from air to water, the "loss" does not reach 40 db. Taking the impedance of water ( $Z_w$ )=145,000 and of air ( $Z_A$ )=41.2 the fraction of the incident wave which is reflected is given by

$$\frac{Z_w - Z_A}{Z_w + Z_A} = 0.9994.$$

Thus 0.0006 of the total energy enters the water which represents a drop of about 36 db. Now we have already seen that there is no reason to believe that the impedance of the cochlea is anything like as great as 145,000. If this is correct we are entitled to argue that much more than 0.0006 of the energy would enter the cochlea from a wave directly incident on the stapes, so that including the area factor (drum to stapes) it is possible that the middle-ear mechanism only provides a direct magnifying factor of the order of 25 db. Can this be its sole function? We obtain a clue to the problem when we consider more closely what would happen if sound impinged directly on the inner tympanic wall. We note that in addition to the pressure wave originating at the stapes, a similar wave will start from the fenestra rotunda and their composite effect will tend to annul any possible movement of the basilar membrane. Bekesy has discussed this problem—not very convincingly. In the writer's opinion differences in the size and rigidity of the membranes in the two fenestrae, together with a possible minute phase angle allow some movement to take place. At any rate, it is not difficult to see why most radical mastoid operations result in a gross deafness. The drum ossicle mechanism overcomes this difficulty as follows: To begin with it magnifies the thrust on the stapes by a factor which is at least 30 and may be much more. In addition to that, however, because of the tenseness of the drum and its minimal excursions, practically no sound energy is transmitted to the air in the middle-ear cleft. Thus the fenestra rotunda is not normally disturbed by external sound and so is free to move under the impact of the oscillating perilymph. It appears from this that the effect of a central perforation is not only to reduce the effective area of

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the drum, but also, to stultify to a certain extent the normal cochlea action by transmitting to the fenestra rotunda pressure waves in opposition to the main waves at the fenestra ovale. Even so, the deleterious effects of such a perforation are trivial compared to what happens with the post superior perforation. In that condition, the discharge descending from the antrum seeps continually past the very vulnerable incudo stapedial joint. Pathological subluxation rapidly supervenes, and this, together with thickening and fibrosis of the annular ligament of the oval window results in serious loss of hearing. We might tentatively assess the physical disability from a large central perforation with no other pathology at 10 db. Subluxation of incudo stapedial joint with no other pathology at 25 db. to 30 db. Subluxation of incudo stapedial joint with fibrosis of staped ligament 30 to 60 db.

The problems and theories discussed above seem at first sight to be academic and of little practical importance. The writer does not possess the physiological, mathematical or physical knowledge which would be necessary for a rigorous analysis of their implications, but enough has surely been said to dispel any complacency as to our comprehension of the auditory function. Thus the physical implications of the fenestration operation have never been seriously considered, nor for that matter, of Hughson's round window grafts. The impedance of the ear has been carefully investigated at threshold, but no work has been done on the possible changes in impedance with increasing intensity. This may ultimately be of importance in the design of telephones and hearing-aids. It should not be impossible to pass a cannula up the Eustachian tube so as to investigate the acoustic phenomena in the normal middle ear. And we are urgently in need of experimental information on the effect of segregating one or other of the fenestrae. In that way we might hope to explain the occasional brilliant result obtained with the "old fashioned" artificial drum. The above tentative analysis of the factors in suppurative deafness would suggest that mobility of the stapes is of even greater importance than integrity of the ossicular chain and may ultimately necessitate a more urgent attitude to the functional surgery of chronic otorrhœa. The investigations of such questions demands the resources of large scale laboratories and the co-operation of physiologist and physicist. In these respects our American and Continental colleagues are more fortunately placed than we British otologists are, and it is to be hoped that provision will be made in the near future for a serious attack on those unsolved problems in our theory of the auditory function.

### Summary

Some aspects of the mechanical action of the auditory apparatus are reviewed. The damping of the cochlea is discussed and a new theory of its nature proposed. The middle-ear mechanism is described as

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pressure driven and the deduction made that the function of the intra-tympanic muscles is that of "attention". Some criticisms of the standard "protection" theory are included. A tentative explanation of the obliquity of the drum is proposed. A protective device against loud noise is proposed in the cochlea itself.

A possible explanation for the "recruitment of loudness" and for the variation of pitch with intensity is offered.

A plea is made for further research with tentative suggestions as to possible lines.

## APPENDIX

### SOME PHYSICAL PRINCIPLES

An "infinite" medium\* transmits waves of any and every length, with a constant velocity  $C = \sqrt{\frac{E}{\rho}}$  where  $E$  is the coefficient of elasticity and  $\rho$  is the density. In a finite medium, boundary conditions are imposed which determine the dimensions of the waves which can be transmitted. Thus a violin string of length  $l$  held firmly at  $A$  and  $B$  imposes the condition that only those waves can develop which allow  $A$  and  $B$  to remain at rest, i.e., as nodes. Thus waves of length  $l : l/2 : l/3 : l/4$  etc., can occur giving the well known relations of the fundamental to its harmonics.

Similarly, a concert hall, though in general large enough to be regarded as infinite, can, if badly designed, develop standing waves for certain frequencies.

The boundary conditions of a finite medium, i.e., its dimensions, together with its intrinsic characteristics of density and elasticity, determine its modes of free vibration, i.e., its natural frequency.

The vibrations of a frictionless elastic system can be expressed by the (simplified) equation  $A_t = A_0 \sin \omega t$  where  $A_t$  is the displacement at time  $t$  and  $A_0$  is the maximum displacement. Such a system has a frequency  $f = \frac{\omega}{2\pi}$ .

### THE DAMPING VERSUS SELECTIVITY PARADOX

In practical problems no system is frictionless. Its energy is dissipated—or damped—in many ways, of which the commonest is degradation of kinetic energy into heat, i.e., friction. Another example is the loss of energy from a tuning fork by radiation of sound. These losses are in general proportional to the velocity. Consider the effect on the above vibrating system of a friction of  $2r$  per unit mass per unit velocity.

The requisite equation is now  $A_t = A_0 e^{-rt} \sin qt$  where  $q = \sqrt{\omega^2 - r^2}$ . The frequency has altered from  $\frac{\omega}{2\pi}$  to  $\frac{q}{2\pi}$ .

Normally  $r$  is small compared to  $\omega$  so that the natural frequency is hardly affected by the damping. In certain cases, however (as in the dead-beat

\* Infinite here, as in most physical problems, means large compared with the object discussed; in this case the wave length.

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galvanometer) damping is deliberately increased and if  $r$  is made equal to  $w$  the system is critically damped.  $q=0$ . Its frequency falls to zero. When displaced it sluggishly returns to its resting position without completing a cycle. If we consider the cochlea as a series of resonators, then to say that those same resonators are critically damped makes nonsense of the Helmholtz theory because they must all be reduced to zero frequency as above and there can be no selective response due to resonance.

The factor  $e^{-rt}$  obviously steadily diminishes as  $t$  increases. This expresses the obvious fact that the amplitude of displacement diminishes logarithmically as time goes on. In other words damping brings a system to rest, logarithmically.

## THE "ON" AND "OFF" EFFECT

Consider the effect of a periodic force  $F_t = F_0 \sin nt$  on the above system.

Whatever the natural frequency of the system, it eventually settles down to oscillate at (practically) the same frequency as  $F$ . This is the condition of forced vibration. At the onset of forcing, however, the system exhibits a composite form of vibration in which the natural and the forcing frequencies are compounded. This is the so called "on effect". The natural vibrations are damped out, more or less rapidly, leaving the forcing frequency as described above. When the force ceases, the system tends to fall into its natural frequency, and so during the short period before it comes to rest, it exhibits an "off effect", which is a composite vibration of the same type as the "on effect".

The required equation is  $A_t = be^{-rt} \sin qt + d \sin nt$

$be^{-rt} \sin qt$  represents the transient vibrations at the natural frequency  $q$ .

$\frac{2\pi}{n}$

The factor  $e^{-rt}$  shows that they diminish logarithmically.  $d \sin nt$  represents the forced vibrations at the same frequency  $\frac{n}{2\pi}$  as  $F$  and of constant amplitude =  $d$ .

## AMPLIFICATION DUE TO RESONANCE

Although the natural frequency plays no part in determining the final frequency under forcing, it has a definite effect on the amplitude. The greater the disparity between natural and forcing frequencies (i.e., between  $w$  and  $n$ ) the smaller will the forced vibrations be.

Fig. 14a shows the amplitude of a vibrating system in response to varying frequencies. It shows a sharp peak at P where the forcing frequency is (practically) equal to the natural frequency. This is the condition of resonance.

We now enquire what effect an increase in damping has on the amplitude. Fig. 14b shows the behaviour of the same system under increased damping. The excessive vibration at resonance has been proportionately much more reduced than at other frequencies, and we see once more that if a series of such resonators is critically damped Fig. 14c, they will all respond equally to all vibrations and the series will lose its analysing function. Conversely, if damping is reduced to a minimum the resonating element will oscillate much

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more violently than any other element. Such a series will be highly selective.

Thus, in a simple harmonic analyser, selectivity (i.e., magnification due to resonance) is inversely proportional to damping.

Now consider a vibrator which has been set in motion, and then left to vibrate freely. The less the damping, the longer will its vibrations persist.

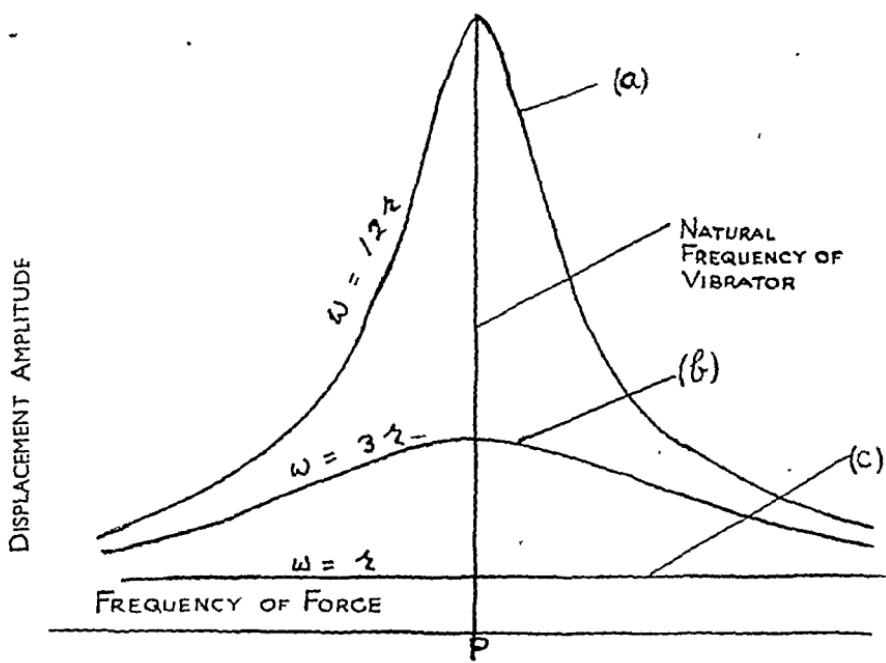


FIG. 14.

Amplification due to resonance.

Maximum displacement amplitude occurs when the forcing frequency equals the natural frequency of the system. This maximum becomes less pronounced as damping ( $r$ ) is increased. At critical damping ( $\omega=r$ ) amplitude due to resonance is completely abolished.

i.e., persistence is inversely proportional to damping. Combining these two relations we see that in a simple harmonic analyser selectivity and persistence must be closely related to each other.

## REFLECTION OF SOUND WAVES

Let a plane progressive wave traverse a medium A and impinge on a medium B at right angles. Fig. 15. At the inter surface X Y part of the incident sound energy is reflected back on its course. The remainder enters B. If  $Z_a$  and  $Z_b$  are the respective impedances of A and B, it can be shown that the proportion of energy reflected  $= \frac{Z_a - Z_b}{Z_a + Z_b}$  clearly if  $Z_a = Z_b$  no energy is reflected.

The impedances are matched and energy transfer is one hundred per cent.

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## ON IMPEDANCE

It can be shown that the equations of alternating current circuits represent the behaviour of oscillating mechanical systems if we make the following symbolic transformations :

ELECTRICAL	MECHANICAL
Inductance	Mass
Resistance	Friction
Capacity	Compliance
E.M.F.	Force
Charge	Displacement
Current	Velocity

In a direct current circuit, by Ohm's law, Current =  $\frac{\text{E.M.F.}}{\text{Resistance}}$  i.e.,  $I = \frac{E}{R}$

In an alternating current circuit allowance must be made for inductance and capacitance, and in the above equation resistance  $R$  is replaced by impedance  $Z = \sqrt{\frac{R^2 + (wL - \frac{I}{C})^2}{wC}}$  where  $L$  = inductance and  $C$  = capacity.

For some value of  $w$  the quantities  $wL$  and  $\frac{I}{C}$  are equal. Thus,  $Z$  for that frequency =  $R$ . This is the condition for resonance, because  $Z$  is now a minimum and therefore, the current is a maximum.

Similarly, the velocity of a free mass will be determined entirely by the friction, but the velocity of an elastic system containing friction and stiffness ( $\frac{I}{C}$ ) will be determined by its mechanical impedance which has the same complex formula as the electrical impedance. At resonance the mass and elastic reactances cancel and the system is friction controlled.

The electro acoustic analogy reappears in the equation for energy. Just as in electricity  $J = \frac{E^2}{R}$  so in sound the intensity is given by  $J = \frac{p^2}{r}$  where  $p$  is the variation in pressure and  $r$  is the impedance.

The significance of impedance is a recurring theme in this article, and in the writer's opinion its accurate evaluation under varying conditions might well add to our knowledge of the auditory mechanism. The main work has been done by Geffcken and Troger in Germany, and by West in this country. Values have been determined over a frequency band from 300 to 3000 c.p.s. These have only been determined at threshold and it is more than probable that they would vary with increasing intensity. Further investigations might provide information as to the function of the muscles, and in any case, should include higher frequencies. Geffcken points out that the variation in the sensitivity of the ear at different frequencies must be attributed to variations in impedance. Optimum sensitivity occurs about 2000 c.p.s. where the ear impedance is closely matched to that of air. At 300 or 3000 c.p.s. the matching is not so good and so energy transfer is diminished. It is thus quite possible that for a given amount of energy entering the cochlea, the fibrils are equally sensitive.

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In an alternating current circuit the current used in setting up the electro-magnetic field around the inductance, and also the electro-static strain in the condenser dielectric is referred to as "wattless" because it drains no power from the source. Once it has been established, it merely swings to and fro. The real power drain is due to the resistance losses (neglecting radiation, etc.).

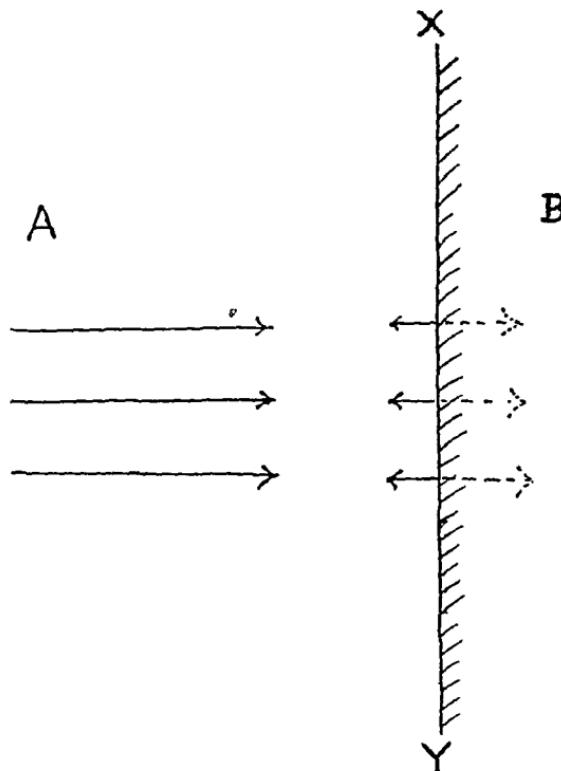


FIG. 15.

Transfer of energy from one medium to another depends on the ratio of impedances.

In the same way the velocity and elastic strain in a mechanical system are wattless. The real power consumption in the system depends on  $R$ . Impedance diagrams enable these factors to be separated. True resistance is measured along the real, or  $X$  axis, whilst reactance is measured along the imaginary or  $Y$  axis.

It has been shown that in the cochlea  $R$  can be sub-divided into

1. True frictional (viscosity) losses.
2. Functional damping.
3. Microphonic losses.
4. Reverse radiation.

Is it too much to hope that some day we shall be able to resolve these components and evaluate them separately?

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## REBOUL'S HYDRODYNAMIC THEORY

Reboul has based his theory of the action of the cochlea on the standard equations for wave propagation in a fluid contained in a tube with elastic walls. This is justifiable because the scalae are separated by such a wall, i.e., the scala media.

In an elastic tube (such as an artery) a wave is propagated with a velocity C

given by  $\frac{I}{C^2} = K\rho + \rho \cdot \frac{I}{E} \cdot \frac{D}{e}$  where K is the co-efficient of elasticity of the fluid. D is the diameter of the tube. E is the co-efficient of elasticity of the wall and e is its thickness.  $\rho$  is the density of the fluid.

The mathematical analysis yields a differential equation which can only be solved by making certain simplifying assumptions as to phase. Later it is necessary to assume that C merely varies with D, i.e., that there are no variations in E and e.

Next it is assumed that D diminishes steadily from stapes to helicotrema, so that C must vary in the opposite direction.

This finally leads to a differential equation relating the displacement at any point with the velocity of the wave at that point.

The solution falls into two parts according as the frequency is below or above a certain limiting value. In the former case the displacement shows practically no peak, but in the latter case the membrane shows a pseudo period so that a peak displacement occurs at a point which moves down to the base as the frequency rises, thus conforming with the general picture of pitch distribution. This solution obviously involves no selective resonance in different parts of the basilar membrane itself, since E and e are assumed to be constant.

The main attraction of Reboul's theory lies in his reconciliation of selectivity with near critical damping. His thesis will lose much of its force if alternative solutions to the paradox are available (as in the present article) which are not incompatible with a true resonance theory. The many assumptions and simplifications are inevitable in an analysis of this complexity. They need not be regarded as fatal objections. It may be possible to absorb Reboul's views into a more generalized classical scheme, but for the present the writer's objections to the theory are as follows :

1. It makes no provision for peak vibrations below 1000 c.p.s. Apparently for those frequencies a modified telephone theory is necessary.

2. It disregards the body of histological evidence, which indicates that the cochlear structure is progressively differentiated in a manner which is most suggestive of a resonating function.

3. The picture it evokes of the wave form in the cochlea does not correspond to experimental findings nearly so well as the classical theory. In a second article he marshalls some objections to the resonance theory. "Il est incontestable qu'un son excite, non une fibre ou une groupe restreint de fibres, mais presque toutes sinon la totalité des fibres." This statement must be emphatically rejected. It reminds us of the telephone theory as proposed by Wrightson. The evidence for tone localization in the cochlea, culminating in the investigation of individual fibre responses is quite conclusive.

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4. Lastly, his argument that the nerve impulses are directly evoked by the microphonic (and so must be located at regions of pressure change rather than displacement) has been rejected by most authorities.

Thus, whilst we may admit that the mathematical analysis indicates the possibility of pseudo resonant peaks, it is unlikely that these are the essential factor in the action of the cochlea. The original Helmholtz theory continues to provide the most satisfactory explanation of all available facts.

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## CLINICAL RECORD

### LEECHES AS TEMPORARY ENDO-PARASITES IN THE UPPER RESPIRATORY TRACT OF MAN

By BRIAN REEVES (London)

RECENT events in the Far East have stimulated perusal of the literature on leeches as endo-parasites of man.

At the time of the report of my two cases from the Middle East references were impossible<sup>1</sup>.

In view of the welcome return of fellow citizens from, and occupation of, the Far East, a few notes on an Eastern entity may not be out of place. A leech in the upper air passages is no doubt a rarity in this country but it is commonplace in distant lands and reports come in, notably from China, Japan, India and the Mediterranean.

The Arab world well recognizes the symptoms and a patient will often tell you the diagnosis<sup>2</sup>.

The condition is of such rarity in Europeans that it may be overlooked.

In peace-time there is little likelihood of a European drinking contaminated water but in the appalling conditions under which most prisoners in the Far East have lived, contaminated water may have been the rule rather than the exception.

If a man be really thirsty he will drink anything.

*Pathogenesis.* Infested water is drunk, the leech is taken in while very small and lodges in the upper air passages causing no trouble. Presenting symptoms depend on the size of the leech. The period between "infection" and the first symptom can last many weeks and during this time the host may return to this country.

*Review of the Literature.* No claim is made that this review is complete, and nothing original is presented. The leech as a parasite of man dates from his creation. Gideon recognized the danger of drinking polluted water<sup>3</sup>. An attempt has been made to quote reliable references from countries in which we are particularly interested at the present time.

*China.* Hoeppli and Tang<sup>4</sup> state that "comparatively frequent are cases in which young leeches had been swallowed in polluted drinking water and had fixed themselves in the nasal cavity, the throat and especially the larynx".

In 1941 Ta-Hsiung Chin<sup>5</sup> reported a note of Leech Infection in Man and describes four cases, three from Lotien, Kweichow, and one from Chaotung. All specimens were removed from the human nose and had been acquired from drinking pond, stream or spring water.

*India.* Narayanan<sup>6</sup> 1936 reported a leech in the nose of a child aged 8 who was complaining of epistaxis. He was bathing in a mountain stream in Coimbatore 20 days before the consultation. "On examination, his left nostril showed a brownish mass like a polypus. It was seen to wriggle and could

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not be caught with the forceps." However, the child was "given snuff" and he sneezed it out half an hour later!

*Turkey.* Meyer 1942<sup>7</sup> states that, "the most frequent foreign body found in the wind and food passages in Anatolia is *limnatis nilotica*, the genuine horse-leech, which often attacks man and animal in the whole of the rest of the Mediterranean area".

He reports 100 cases and summarizes by asking (a) "Why should the presence of leeches in the body in spite of the profuse bleeding lead to a severe anaemia; is this perhaps due to toxic origin?" (b) "How is the remarkably small reflex excitability of the larynx when leeches are attached thereon to be explained? Does the parasite, perhaps, give off some anaesthetizing secretion?"

*Japan.* Manson (1874)<sup>8</sup> reports a case of a European becoming infected in Formosa and quotes the patient's written account:

"On the trip to Bankintang, during the Chinese New Year, on the way to the savage village, Budd of Boyd and Co.'s and I drank from a pool in which we noticed small leeches about half an inch in length, and I afterwards picked two or three of them from the roof of my mouth. Some six or eight days afterwards, I was troubled with bleeding from the right nostril and afterwards with considerable pain on that side of the nose. I have seen something protruding several times."

(Signed) I. B. STEERE.

Manson continues, "For some time before the leech was extracted Mr. Steere suffered from pain in the head, vertigo and loss of appetite. He lost flesh considerably. All his symptoms he attributed to severe 'cold in the head'.

"The leech measures about  $1\frac{1}{2}$  inches in length, is of a uniform dark chocolate colour, and is furnished with a very large sucker—in other respects it is like the ordinary *hirudo medicinalis*."

"There can be little doubt that this parasite is derived from drinking water, probably creeping round the velum into the posterior nares or by the anterior nares, especially when stooping down to drink from a pool."

*Abyssinia.* The best modern account comes from Walker and Charters,<sup>9</sup> 1943 who report a case of an Abyssinian aged about 7 years.

He was found by a European Sergeant to be suffering from a severe epistaxis.

"Examination of the throat revealed a circular, sessile tumour of black colour almost filling the pharynx."

"It was attached by its base to the posterior surface of the right tonsil."

Blood examination : Hæmoglobin                  40%

Differential Count :

Polymorphonuclears . . . . .	75%
Lymphocytes . . . . .	16%
Eosinophiles . . . . .	2%
Basophiles . . . . .	1%
Monocytes . . . . .	6%

"A diagnosis was not made pending further examination under an anaesthetic."

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On the following morning the child coughed up a large leech.

*Palestine.* In my two cases<sup>1</sup> the leech was in the trachea below the vocal cords and both cases presented with cough and blood stained sputum.

The parasite was removed by direct tracheoscopy under general anaesthesia. Local anaesthesia would be the method of choice in a co-operative subject.

My patients were excited Arabs who could not understand English.

*Egypt.* Dominique Jean Larrey (1803) "a very talented and upright French Military Surgeon"<sup>10</sup> gives an excellent account of the soldiers' difficulties with leeches in Egypt.

"Our troops, driven on by thirst, threw themselves flat on their faces at the edge of these pools, and, not giving a thought to this new enemy that was lying in wait for them, they drank with gusto."

These bites first of all caused a painful pricking sensation felt towards the pharynx; a persistent cough that produced glairy sputum faintly stained with blood; an urge to vomit. This irritation set up by the leech in the sensitive parts of the pharynx, was soon followed by congestion in these parts, as well as frequent haemorrhage. Thereafter swallowing became difficult, the breathing was laboured, and the strain thrown upon the lungs and diaphragm by the coughing gave rise to severe pain throughout the patient's chest. The coughing increased because the leech kept tickling the epiglottis and edges of the glottis with the tip of its tail. (Blood reaching this orifice can give rise to the same symptoms.) The victims visibly wasted away, lost both appetite and sleep, were anxious and restless; and if the appropriate treatment was not given promptly these symptoms made them dangerously ill and could even end in death, as certain cases have shown . . . The first individual to manifest the symptoms was a soldier of the 69th Regiment who, on reaching Ssalahhieh from Syria, was stricken with pricking pains in the throat, coughing and expectoration of blood. The amount he had lost had weakened him considerably. On depressing the tongue with a spoon I exposed the leech whose tail could be seen at the isthmus of the pharynx. It was as thick as the little finger. I at once introduced my dressing forceps in order to seize it. But as soon as I touched it it shrank back and climbed up again behind the soft palate. I had to wait for it to come down again before I could locate it; and then, with a pair of polyp forceps curved lengthways I snatched it out at the first attempt. Its removal was followed by a little bleeding which stopped in a few minutes, and a day or two after this soldier had recovered completely.

During the army's journey from Syria to Belbeys about twenty soldiers were admitted to hospital there suffering from the same complaint. Most of them had leeches situated near the nasopharynx behind the soft palate; in some however, the leeches penetrated the nasal fossae or found their way into the oesophagus and from there down into the stomach where they remained for variable periods. They caused the soldiers much discomfort until they were dislodged by medication or the action of the organ itself.

Gargles of vinegar and salt water sufficed to dislodge those leeches that had settled in the oro-pharynx. Sometimes we had to use polyp forceps or inhalations of tobacco and squill-root, sometimes salt-water wash-outs. Two of these patients had not come into hospital until several days after they

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swallowed the leeches and consequently were considerably weakened and dangerously ill . . .

When travellers and troops crossing the desert are forced by circumstance to drink water which might be suspected of containing any insect life, they must strain the water through a thick cloth and add a few drops of some sort of acid, if it can be procured; hence each individual should carry with him a water-bottle, a drinking vessel and a bottle of vinegar."

## COMMENT

1. Attention is drawn to endo-parasitism of the leech in the upper respiratory tract in man.

2. With air evacuation from the Far East the disease may present itself in this country due to the latent interval between infection and symptoms.

3. Symptoms may be one or a combination of, epistaxis, cough, blood stained sputum, hoarseness.

4. Signs :

- (a) Bleeding.
- (b) Edema of mucosa depending on the position of the parasite.
- (c) Viewing the leech by means of anterior or posterior rhinoscopy; laryngoscopy, indirect or direct; tracheoscopy, or bronchoscopy.
- (d) Anæmia.

5. Treatment consists of removal of the parasite by the most appropriate means and correcting the anæmia.

6. The leeches from my cases measured 1·5 cm. and 3·5 cm. after being killed in 10% formalin in normal saline.

As I wished to preserve the specimens intact, the species cannot be stated. Exact identification can only be made on section<sup>1</sup>.

I wish to thank my former orderly Private V. Warr, R.A.M.C., for his translations of some of the references.

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# SOCIETIES' PROCEEDINGS

## ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

March 2nd, 1945

*President*—C. GILL-CAREY, F.R.S.C.Ed.

### Discussion on an Upper Respiratory Clinic for Children *The Willesden General Hospital, London*

F. C. W. CAPPS

THE routine examination of children with nasopharyngeal symptoms is apt to become a matter of habit in clinics strictly confined to their own particular field.

To deal with this, a team seemed to be indicated : (a) To interpret history and symptoms in terms medical and social ; (b) to encourage repeated attendances in order to avoid a hurried decision at a single consultation, to record progress, and to maintain the physiological response to environmental infection free of symptoms ; (c) to investigate the devolution of the mouth-breather and to combine the resources of the speech therapist, rhinologist and orthodontist, to reverse the process ; (d) to deal with nasal and bronchial catarrh as a single pathological entity with the nasal cavities and accessory sinuses as the upper, and the bronchial system as the lower bacterial barrier : (e) to employ routine radiography of the sinuses with the object of early recognition and clearance of occluded areas and soft tissue radiography to show the presence of a pad of adenoids ; (f) to recognize and remove tonsils that are subject to recurrent bacterial invasion and inflammatory reaction, particularly where morbid changes may have taken place which threaten the lymphoid barrier.

In the child it should be possible to correct disturbances before an established pathological state supervenes. It is not easy to keep this viewpoint when one is seeing children in a general clinic. An E.N.T. Clinic for children only was therefore started.

The team at present consists of a social worker, rhinologist, speech therapist and orthodontist. Children are seen by members in this order, but not necessarily on the same day. We should also have a paediatrician and he may be the controlling member.

The persistent mouth-breather has been our especial concern. The association of a rhinologist and orthodontist to investigate this condition is not new, for Warwick James and Somerville Hastings read a paper on "Mouth

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"Breathing and Nasal Obstruction" to the Section of Odontology in 1932. (*Proceedings*, 25, 1343).

During childhood the sinuses are not fully developed, and the pharyngeal lymphoid tissue undergoes physiological hypertrophy.

It is of interest to note that at puberty when the sinuses reach a stage of development comparable with that of the adult, the phase of lymphoid hyperplasia is replaced by a process of atrophy; if the tonsils and adenoids are removed at an age when the sinuses are immature, a generalized hyperplasia of the pharyngeal lymphoid tissue may follow.

Routine serial radiography has proved to be essential in the correct interpretation of symptoms referable to the upper respiratory tract. Thickened or oedematous mucosal linings (56% in summer and 65% in winter over a series of 360 cases recorded in 1942-43) were rarely followed by infected antra. Surgical treatment was not indicated.

The high incidence and transient nature of sinus opacities suggest that the lining mucosa shares in the defensive reactions of the upper respiratory tract, but the precise relationship with the inflammatory reactions of the lymphoid tissue is uncertain.

Our aim in treatment throughout should be to temporize until stability is reached.

Lack of aeration and occluded ostia are the precursors of impaired ciliary drainage and retention of secretions. Proof puncture and aspiration, followed by repeat puncture and irrigation or ephedrine displacement, is employed in selected cases and progress controlled by serial radiography.

Exclusion of an established upper respiratory infection is essential before interference with the lymphoid barrier is contemplated.

In discussion of the tonsil problem here in 1940 (*Proceedings*, 33, 347), repeated attacks of inflammation received priority and were held by some to be the only indication for operation. The observation of Kershaw at that discussion is worth repeating—"that operation during the stage of physiological response to environment is contra-indicated".

An investigation made in 1931 suggests that a deficiency in the diet of fat-soluble vitamins is one of the factors, though not predominant, which tends to produce an overgrowth of adenoid tissue. Increased knowledge of causation and prevention can only come from a more thorough medico-social investigation of the first three or four post natal years and maternal history during pregnancy.

In 1943 there were 557 new cases and attendances for progress numbered 2,400. Tonsils and adenoids were removed from 216, that is 48%. For 1944 the new cases were 440, attendances for progress 2,200, operation for tonsils and adenoids 158, or 36%.

We do not advocate that the clinic be copied until it can be shown to produce results superior to those already attained by the older methods of isolated consultant clinics.

E. GWYNNE-EVANS

*The mouth-breather problem.*—The respiratory function requires the co-ordination of many muscles. Co-ordinated movement is an interplay between



SOFT TISSUE PROFILE RADIOGRAPHS (MOUTH OPEN)

The habitual co ordination of the palato-lingual musculature free of conscious control  
1 In the presence 2 In the absence of adequate levels of tone and neuro-muscular  
activity



FIG. 2,  
Failure of the palato-lingual reflex to close  
the faucial isthmus results in mouth-  
breathing



FIG. 1  
An active palato-lingual reflex closes the  
faucial isthmus and preserves nasal  
breathing

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reciprocal muscles in alternating contraction and relaxation—two opposite physiological actions of muscle activity.

Although there can be no absolute state of muscle rest owing to tonus, the position of physiological rest corresponds to the normal position of equilibrium between antagonists.

A colour film was made demonstrating the reciprocal co-ordination of the tongue with the palatal velum in closure of the faucial isthmus.

These observations were supported by a large number of soft tissue radiographs of the palato-lingual musculature at physiological rest.

Serial radiographs have demonstrated the stability of the palato-lingual patterns, when care has been taken to ensure that the musculature has assumed the habitual position of rest before exposure is made.

The radiological pattern depends on the degree of tone and the habitual co-ordination of the musculature. Normally, if the mouth is open, the shadow

## TRACING OF A SOFT TISSUE PROFILE RADIOPHOTOGRAPH. (PARTLY DIAGRAMMATIC.)

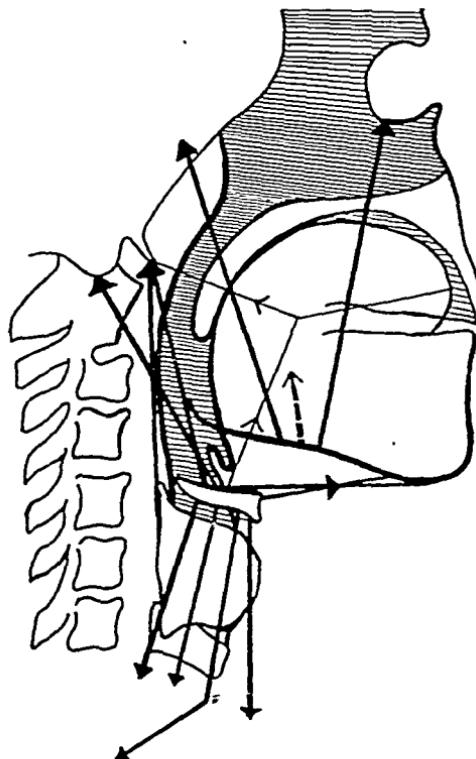


FIG. 3.

The holding muscles of the skeletal framework in relation to the airway.  
Reciprocal opponents in a state of balanced equilibrium, i.e. the position of physiological rest.

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of the palatal velum is contracted round the base of the tongue, which is elevated and retracted to close the palato-lingual space.

When the musculature is unduly relaxed, the jaws are open, but the arching of the tongue is inadequate, and the palatal velum occupies a midway position between the post-nasal and palato-lingual spaces.

In the presence of an obstructive pad of adenoids, the jaws are usually open, and the co-ordination of the musculature is disturbed. The adenoid shadow may obliterate the post-nasal space, the posterior mass of the tongue is depressed away from the palatal velum, whilst the tip of the tongue may impinge against the pre-maxilla.

These are two distinct patterns of the established mouth-breather; the pattern of the intermittent mouth-breather may be indeterminate.

Negus has shown that keen-scented mammals are provided with an elongated palate which is in contact with an efficient epiglottis to preserve the olfactory sense with the mouth open. He has pointed out that with ". . . the recession of the jaws and the flexion of the head on the vertebral column; the larynx has descended in the neck, being forced to do so by the tongue, which assumes an arched shape. The result is the separation of larynx from nasopharynx with a wide gap between epiglottis and soft palate . . .". We have repeatedly observed that an open mouth is not necessarily indicative of mouth-breathing but the palatal velum forms a tense low arch meeting the posterior mass of the tongue which is instinctively drawn upwards and backwards to close off the oral cavity from the airway.

Whilst we partly agree with Somerville Hastings and Warwick James that the reciprocal co-ordination of the tongue with the palatal velum constitutes a posterior oral sphincter, we suggest that the palato-lingual mechanism is basically a postural reflex, comparable to the reflex action of the glottis, and is a valve which is closed to preserve the function of nasal respiration if the mouth is open.

The reflex rhythm of the lower respiratory musculature is modified by the development of the cortex, but remains essentially automatic, and is less vulnerable than the evolutionary younger upper respiratory musculature which comes largely under the influence of cortical control. As the child learns to master his muscle activities they become a reflex practice, and the higher level control is replaced by a lower level mechanism with the development of muscle sense. Until the stage of stability is reached, the facial, lingual and palatal musculature is particularly prone to disturbances of co-ordination.

The most serious cause of muscle disturbance is loss of tone. Although any number of factors may produce the picture of the hypotonic child, tonus is basically a neurogenic property of muscle activity in which both higher and lower centres are concerned. The role of the higher centres is uncertain, but the frequent association of a dull mental attitude as a primary rather than a secondary factor should not be overlooked.

In the opinion of Sir Arthur Keith and G. G. Campion, the "narrow deeply arched palate, the so-called 'adenoid facies', is not a single defect in an otherwise well-developed face, but part of the failure in the general growth of the face".

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We suggest that persistent mouth-breathing also, is not necessarily a single defect secondary to post-nasal obstruction in an otherwise healthy child, but may be part of the general failure in the proper development of neuromuscular activity. When combined with a dull mental attitude, habitual mouth-breathing might then be characterized as a true functional disorder.

An attempt has been made to analyse disturbances in terms of functional "dissolution", an expression used by Hughlings Jackson as meaning the "reverse of evolution"; it is a method of approach that has already been adapted to speech pathology by Leopold Stein.

The preponderant holding muscles of the mandible are the masseter and temporalis. The mechanism in closure of the jaws is stronger than the mechanism of opening, so that when the musculature is normally relaxed, the mandible assumes a balanced position in light occlusion with the maxilla, known as the resting bite.

Failure of muscles follows a devolutionary sequence, affecting some, but nor necessarily all, of their functions. Undue relaxation of the musculature allows the mandible to be released at any age; in older children, flaccid muscles of facial expression and certain speech defects including some deviations of nasality indicative of palatal disturbances are among the earlier signs. Mouth-breathing supervenes when the framework of the palato-lingual pattern is also relaxed, with a diminished or absent reflex to effect closure of the faucial isthmus when the mouth is open.

Stagnation of nasopharyngeal secretions may result from the added failure of the palato-pharyngeal musculature, to effect proper drainage of the post-natal space.

Functional weakness is distinct from an organic paresis that would result in regurgitation of fluids through the nose. Negus points out that the swallowing movement commences in the highest part of the nasopharynx with the ". . . raising of the soft palate and closure of the nasopharyngeal isthmus by approximation of all its walls; initial closure is followed by a wave of constriction effected by the superior constrictor muscles with the object of squeezing out mucus, debris and bacteria dumped by the ciliary streams of the nose and sinuses to be carried downwards through the pharynx into the oesophagus and stomach". When secretions are allowed to remain in contact with the pharyngeal wall for any length of time a subsequent lack of sensitivity to initiate the swallowing reflex increases the liability for nasopharyngeal infection to follow the alternative physiological route into the tracheo-bronchial system.

Enlarged tonsils or adenoids interfere more directly with velar action and the drainage mechanism. On the other hand, the constant repetition of oral breathing as the result of an inability to overcome persistent post-nasal obstruction will produce a wrong habitual co-ordination of the palato-lingual musculature which may or may not continue after the cause of the obstruction has been removed.

The Orthodontist has related failure of the orbicularis oris and alae nasi in some cases to a state of imbalance among the facial muscles associated with a malrelationship between the jaws.

*Methods of investigation.*—Children are examined jointly by the rhinologist, speech therapist and orthodontist. The upper and lower respiratory mechanisms

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are grouped together as reciprocal antagonists and considered in terms of neuromuscular activity under the growing influence of cortical control. Clinical estimation of function is supported by radiography. A profile radiograph of the palato-lingual musculature is exposed in the habitual position of rest during quiet respiration, and the costodiaphragmatic rhythm is observed under the fluorescent screen. While it is usual to relate the respiratory musculature to the postural balance of the body segments, the Orthodontist has taken a new departure by relating the upper respiratory musculature to the craniomandibular and cervical segments.

*Management of cases.*—Early recognition and clearance of occluded airways is an essential requirement whilst tonsils or adenoids that interfere with velar action are removed. It has become increasingly evident, however, that management of the habitual mouth-breather implies not only re-education of the anterior oral musculature, but the cultivation of tonus and reflex neuromuscular activity in the posterior groups of muscles that are responsible for ventilation and drainage of the nasal spaces.

*Anterior oral musculature.*—The plan of rehabilitation is considered from the myogenic aspect that "the position of rest is the physiological basis for re-education of muscle function" (Colin Mackenzie) and from the neurogenic aspect, by bringing muscle action into the conscious plane through games, exercises and devices that are designed to cultivate tonus, and by blazing a pathway through the synapses, encourage reflex muscle activity free of conscious effort, until correct habits of co-ordination are finally formed.

The Orthodontist's observations on the developmental pattern of the jaws in relation to the behaviour of the facial musculature and nasal respiration led us to adopt his method of using a modified Andresen appliance as an intra-oral splint to obtain an optimum relationship between the jaws and a state of balanced equilibrium between the muscles.

Re-education is begun as the orbicularis oris and attendant muscles of facial expression are actively moulded round the renewed basic support, and the previous unconscious behaviour patterns are upset.

Reflex tonus of the musculature is cultivated through the conscious effort necessary to hold the appliance in place at intervals during the day. Later, the splint may be retained without further thought or attention as a habit, and can be worn mostly at night.

Re-training of the anterior groups of oral muscles in correct habits of co-ordination involves neuromuscular pathways that are inter-related with the development of speech, and it may be desirable to pass cases through the hands of the speech therapists for special exercises before adequate kinaesthetic control is regained. An inability to combine the association of muscles at the necessary speed required for speech may call for a prolonged course of speech therapy.

*Posterior oral musculature.*—We regard the palato-lingual and palato-pharyngeal mechanisms as reciprocal antagonists that are not entirely under direct control, but are largely ruled through lower levels of the nervous system. The cultivation of tonus and reflex neuromuscular activity in the posterior groups of muscles are therefore not so dependent on bringing muscle action into the conscious plane. The Orthodontist has observed that recurrent



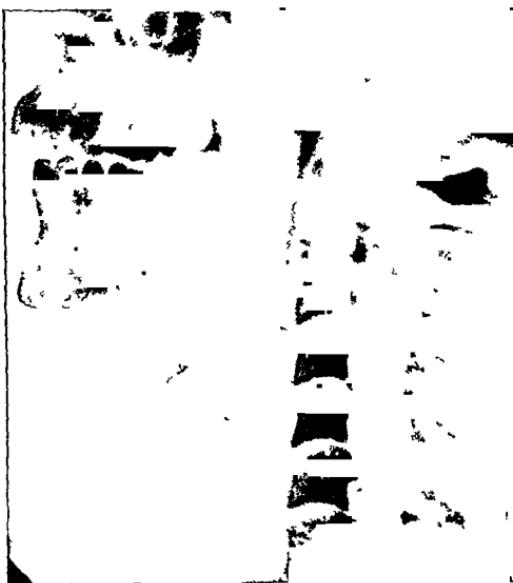


FIG. 1

The low level of the hyoid related to relaxation  
of the lingual musculature



FIG. 2.

Same case after 10 months' treatment  
Increased tonus of the musculature Note  
relative positions of hyoid bone

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acts of swallowing are induced by the presence of the appliance in the oral cavity and they probably play a large part in "reconditioning" the posterior oral reflexes.

*Comments.*—There are indications that recovery of function follows the evolutionary sequence. Radiological evidence of palato-lingual closure has been persistently obtained, but tonicity of the facial muscles and the reflex closure of the orbicularis oris free of conscious effort have been more difficult to achieve.

Where post-nasal obstruction has led to a wrong co-ordination of the musculature and large tonsils have interfered with velar action, palato-lingual closure has also been obtained following operation in some, but not all cases.

*General considerations.*—Failure to maintain proper extension of the vertebral column plays an important part in the respiratory disturbances of the mouth-breather. Exercises and games which draw the child's attention to those groups of muscles that are involved in the general extensor reflex are combined with methods that encourage correct reflex habits of breathing.

A paediatrician is to be appointed to assess environmental, nutritional and metabolic factors that contribute towards hypotonus. The advice of a child psychologist is also required to determine intelligence levels and psycho-emotional factors before we are justified in suggesting that persistent mouth-breathing in the presence of a dull mental attitude may be a true functional disorder.

We have yet to judge the practical value of these methods of approach before they can be accepted as part of the routine procedure in the E.N.T. Department.

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## ARNOLD A. NOVE

I have observed that children with malrelated jaws and malposed teeth have not only facial asymmetry but tend to develop a stooping posture and winged scapulae. These are associated with post-nasal catarrh and other respiratory symptoms.

Close analysis will reveal this as a state of imbalance between intrinsic and extrinsic musculature of the head and neck.

Small dental arches and short or obtuse ascending rami prevent the tongue from occupying its proper position in the oral cavity. Instead of lying horizontally with its tip touching the lingual surfaces of the anterior teeth, the tip of the tongue abuts against the palate (behind the pre-maxilla). This causes the tongue and hyoid to sag, involving other closely related anatomical structural units connected with deglutition and respiration. This muscular imbalance, with consequent sagging of the tongue, is associated with facial disharmony as well as postural defects (*see figs. 1 and 2*).

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Thus, the most important clinical factor connected with the syndrome described in the opening paragraph is the position of the tongue in the oral cavity.

In the normal individual the integration of the structural units connected with mastication, deglutition and respiration produces a state of equilibrium—with the mandible and hyoid bone as a combined pivot or fulcrum.

In action a gentle synergic wave of contraction includes the temporal, the masseter, orbicularis oris and hyoid group, ending in a quick, uninterrupted, effortless act of deglutition, followed by relaxation. When the jaws are wrongly apposed medially, anteroposteriorly or vertically, this indispensable fulcrum is out of true and all the structural units connected with mastication, deglutition and respiration are compelled to act by adaptation.

Under favourable or normal conditions we have a distinct pattern of deglutition behaviour easily observed clinically, just as a normal gait has a definite pattern or character. Therefore only a correct anatomical relationship of the units concerned will permit free or physiological function of mastication and deglutition.

To correct faults the bony framework must be so reconstituted that the bimaxillary space provides ample room for the physiological requirements of the tongue, thus correctly positioning the larynx with the nasopharyngeal space.

The achievement of this ideal integration of structural units is an orthopaedic problem of some complexity and I would define this new approach as "cervico-facial orthopaedics".

After the jaws have been orientated in accordance with the above physiological requirements an improved Andresen type of splint is used for intermittent wear (mostly at night). Such craniomandibular intermittent immobilization with the corrected orientation allows the musculature to develop and the osseous structures to maintain their corrected position. The jaws being apposed by the splint are provided with the necessary fulcrum for the musculature during each act of swallowing and keep the airway in normal function from the moment the splint is worn. Fortunately, muscles being very readily trained, the splint provides the necessary stimulus for remoulding of the skeletal framework in response to the newly imposed muscular stresses, in accordance with the well-known principles of bony reconstruction as propounded by John Hunter, Wolf and others—frequently alluded to as "Wolf's law".

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## JOAN H. VAN THAL

The aim is to restore function by getting the patient to perform actions already within his scope, based on innate patterns, though these patterns may be dormant. Fatigue and boredom must be avoided, and unnecessary effort or inappropriate responses eliminated.

For the young patient the approach is largely through games that give him the mental picture on which to base his respiratory behaviour; activity starts from relaxation and is not superimposed on musculature that is already fatigued. The games and exercises bring respiration into the conscious plane, i.e. under cortical control; thus correction and adjustment can be achieved, until a habit is formed, or, in other words, a conditioned reflex established.

In some cases inhalational therapy has been combined with breathing exercises. The patient was either admitted to the ward for two weeks, and three times daily inhaled a 5% carbon dioxide-95% oxygen mixture through a B.L.B. mask for about fifteen minutes, or the child attended as an out-patient once a week and had inhalational therapy prior to breathing exercises.

Observation under the fluorescent screen of the response in the case of G. C. furnished interesting data: Told to take a deep breath the boy moved his shoulders up and down, and diaphragmatic descent was almost nil. While inhaling the mixture of carbon dioxide and oxygen, clavicular breathing was spontaneously replaced by costodiaphragmatic action. Without the mask performing his breathing exercises, the extent and rhythm of the costodiaphragmatic excursion were maintained in the same degree. This observation demonstrates that breathing exercises can set up normal respiratory behaviour. Often it is more practical to do such exercises than to inhale carbon dioxide and oxygen in order to stimulate the reflex response.

Unless intelligent co-operation from the mother is assured, breathing exercises are not given to children below the age of 6.

Care is taken to eliminate the common error of raising the cage of the thorax under the illusion that this is tantamount to expanding it. Exercises and games are devised to encourage relaxation, flexibility and rhythm of the costodiaphragmatic musculature rather than attempting to increase capacity.

Attention to posture is maintained throughout. The child may be referred to the physiotherapy department later.

Weekly attendance is advocated for a period of about three months and after that, fortnightly or monthly for another six months, with home practice

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between hospital attendances. Each child attending for respiratory rehabilitation has twenty minutes' individual attention. Children attending for ephedrine displacement are given a few minutes of routine exercises immediately after that treatment has been carried out.

Some of the playful exercises for the facial muscles and upper airway are carried out as follows :

(a) Observations of the difference between an open and a closed mouth : (1) By visual means ; (2) by noting the different sensation when the lips are parted and when they are in contact. *For example*, the child pretends to be a fish, swimming about opening and shutting its mouth.

(b) Maintaining closure of the lips. *For example*, the patient sits in front of a mirror mainly occupied by listening to a story or something else that holds his interest, and at the same time is watched to see if his lips remain shut. This alternative occupation avoids stress.

(c) Intermittent clearance of the upper airway. Encouraging use of the upper airway. (1) The child pretends to smell flowers or to be a dog sniffing at its dinner ; (2) a game of blowing at some object such as a feather through the nose to hit a target ; (3) using nasal resonance, i.e. humming.

THE CHAIRMAN (BRIGADIER MYLES FORMBY) said that the great importance of team work in a problem of this nature had been shown. It had been emphasized how wrong it was to anticipate that by dealing with one aspect only of a problem such as this, successful results would be obtained in anything but a very small percentage of cases. He had in mind particularly the removal of the tonsils and adenoids to remedy such conditions as mouth-breathing. Many must have felt bitter disappointment on finding that the child after operation went on as before, with his faulty breathing.

E. MUSGRAVE WOODMAN, after thanking the openers for this broad and interesting survey of the problem, asked for further practical details about the interdental splint. How long was it worn during the day ? Was it taken out for meals ? On how many occasions had it to be retrieved from the oesophagus ? It would be interesting to learn from their dental colleagues how they overcome the difficulty of the long central incisors which frequently projected over the lip and prevented the lips from coming together. One was accustomed to dental splints for restraining the line of the teeth. Did the interdental splint take the place of the metal retention apparatus wholly or in part ?

C. P. WILSON said that the opener's demonstration had been a revelation, and if he made any criticism he hoped it would not be considered out of place. He was sorry that no mention was made of the type of patient with what he might call the short upper lip. They had heard nothing at all about the importance of the use of the lips as a factor in moulding the shape of the jaws and mouth in addition to the splinting apparatus.

He understood Miss Van Thal to say that it was not practicable to do anything in the way of breathing exercises with children under 6. With this he disagreed. Miss Van Thal had also said that it was important that the child should not observe if it was opening its lips during breathing exercises. His own feeling was that the most important thing was that the child should

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close its lips unconsciously, not consciously, and there was a simple way of making the child do that, namely by the holding of something in the lips. His own practice had been to make children do breathing exercises for five minutes night and morning. This consisted of holding a light wooden spatula between the lips and while doing so they did active movements, either exercises or playing a game. By doing so they developed the power of breathing deeply through the nose and at the same time holding their lips tightly closed unconsciously, because if they were going to hold a stick in their lips they were not thinking in terms of closing the mouth, but merely of holding the stick, and thus they developed the habit of breathing deeply with unconscious closing of the lips.

DR. L. STEIN said that the approach which Mr. Gwynne-Evans had outlined was a method of approach which he had used for many years in speech therapy. In any case of disturbance it was always the lower level that took over and became dominant. Thus, it was not a loss of function which was encountered but rather a different pattern of function according to what was dominant on that level. Miss Van Thal had referred to the use of such games as pretending to be a fish and so forth. The appeal was to the child's primeval instinct, and by this means the muscle tone was increased, because that was closely associated with the emotional meaning. He did not think that tone could be increased by mere exercises but it could be increased if it was correlated with an emotional attitude.

F. C. W. CAPPS, in reply to Mr. Musgrave Woodman, said that the splints stayed in all night. In the use of hundreds of splints it had never been necessary to retrieve one from the oesophagus. They had to be taken out during meals.

A. A. NOVE, in reply to questions, said that one of two reflexes occurs in the presence of a foreign body in the mouth: one, to eject it, the other to swallow it. During consciousness the desire would be to retain it because of the sense of comfort experienced by the different structural units being correlated correctly. In sleep there was occasionally a tendency during the early stages of wearing the appliance for it to be ejected, but whilst the appliance remained in the mouth, the act of swallowing, which normally took place, caused it to be engaged by the lingual surfaces of the upper and lower teeth as well as by the palate. As its external surface was a negative of the lingual surfaces of the teeth, palate, and mandible it brought about intermittent intermaxillary immobilization. Therefore, while the Andresen splint was easy to eject, it was impossible to swallow. With regard to prominent teeth, reconstruction included the alignment of the teeth. With regard to thumb sucking, in his view it was an indication that the child needed space in the mouth as well as support for the musculature and supplied that need instinctively.

JOAN VAN THAL said that she had not been able to give a full description of all the exercises, but these did include holding some object between the lips, such as a quill, which was a playful substitute for the pipe. The under-sixes learned to blow the nose, also to play the games which encouraged them to keep their mouths shut; it was the actual breathing exercises for thoracic

were omitted in their case.

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## ILLUSTRATIVE CASE [Abridged report]

R. W., aged 4 years.

*History.*—Mouth-breathing day and night; snoring and disturbed sleep; recurrent colds; few sore throats. Adenoids removed elsewhere two years ago.

*Upper respiratory musculature.*—1.6.44: Orbicularis oris and muscles of facial expression relaxed; mandible released; no speech defects other than slight insufficient nasal intonation; inadequate palatal depression, with failure to elevate and retract posterior mass of tongue in closure of the faucial isthmus; tip of tongue abuts against pre-maxilla. Profile radiographs: adenoid shadow insignificant; shadow of palatal velum midway between post-nasal and oral air spaces.

### SERIAL RADIOPHGRAPHS OF PALATO-LINGUAL MUSCULATURE AT PHYSIOLOGICAL REST

	Palato-lingual space wide open	Without appliance	With appliance
29.6.44	P.L.S.	Wide open	Wide open
13.7.44	P.L.S.	Open	Open
31.8.44	P.L.S.	Open	Just open
21.9.44	P.L.S.	Just open	Just open
26.10.44	P.L.S.	Just open	Closed
2.II.44	P.L.S.	Closed	Closed
Tonsils persistently inflamed—removed			
30.II.44	P.L.S.	Just open	Closed
25.I.45	P.L.S.	Just open	Closed
25.6.45	P.L.S.	Closed	Closed

*Present state.*—25.6.45: *Posterior oral musculature*: adequate palatal depression, with elevation and retraction of tongue in reflex closure of faucial isthmus.

*Anterior oral musculature*: orbicularis oris and muscles of facial expression have partly regained their tone; mouth remains closed most of the day. There is a tendency for the mouth to drop open at night. Sleeps quietly with appliance in oral cavity.

*Comments.*—Mouth-breathing controlled by posterior musculature: habitual closure of orbicularis oris not completely obtained.

## ABSTRACTS

### EAR

*The Treatment of Acute Suppurative Otitis with Penicillin.* LOUIS WEINSTEIN, M.D., Ph.D. and HILTON B. ATHERTON, M.D., (Boston). *Journal A.M.A.*, October 13th, 1945. cxxix, 7, 503.

Fifty cases of acute suppurative otitis media, 48 complicating scarlet fever, 1 measles and 1 streptococcal pharyngitis were studied.

Bacteriological studies revealed haemolytic staphylococcus aureus alone in 11 cases, beta-haemolytic streptococcus alone in 21 cases, non-haemolytic staphylococcus alone in 10, beta-haemolytic streptococcus and haemolytic staphylococcus were found together in five.

Immediately discharge was noticed penicillin was administered to each of the patients in doses of 10,000 units intramuscularly every three hours and continued until the ear discharge had been absent for at least 24 hours. The average time for the discharge to disappear was 3.9 days. Four cases recurred and were easily controlled by further treatment.

Infections of the middle ear with staphylococcus are more refractory than the beta-haemolytic streptococcus.

None of the patients had any clinical evidence of mastoiditis but X-ray studies revealed clouding of the mastoid cells coincident with the first appearance of the discharge.

Two patients had facial paralysis, one only required a mastoidectomy.

Because of the recurrences the writers recommend that the treatment be continued for 72 hours after the ears are dry.

The article contains four tables.

ANGUS A. CAMPBELL.

*Aural Manifestations of Leukemia.* JOSEPH G. DRUSS (New York) (*Archives of Otolaryngology*, 1945, XLII, iv, 267-274).

The medical records of 148 subjects with leukaemia are reviewed, with particular attention to aural involvement and a more detailed study has been made of 4 of the patients who died and from each of whom a temporal bone was procured for histological examination.

Aural complications of leukaemia are more prevalent than is generally believed. They occurred in 25 of the 148 cases reviewed (16.8 per cent.).

The aural complications include diseases of the external, middle and internal ear and their adnexa. The pathological changes in the ear as elsewhere are comprised chiefly of haemorrhage, cellular (leukæmic) infiltration and inflammation and may be revealed on histological examination even in cases in which there was no clinical evidence of aural disease.

A brief review of literature is given and 8 photomicrographs are presented.

R. B. LUMSDEN.

## Abstracts

*Vestibular Nystagmus caused by Acoustic Stimulation.* P. G. GERLINGS and A. DE KLEYN. *Proc. Nederl. Akademie van Wetenschappen*, 1941, XLIV, 800.

A case described of a woman age 35 who complained of dizziness on pronunciation of the letter N. On examination it was found that pronunciation of the letter N. produced a rotary nystagmus on moving to the left with sometimes deviation of the eyes upwards. Tonal stimulation produced a marked vertical nystagmus with the quick component upwards for the tones 1024 D.V., 2048 D.V., and 4096 D.V.

The author summarizes as follows:—

1. Acoustic stimulation can elicit vestibular symptoms, e.g., a nystagmus, in certain patients.
2. The acoustic stimulation propagates directly to the cristae if a fistula is present in one of the semi-circular canals. This could be demonstrated experimentally by TULLIO, JELLINEK, and HUIZINGA; in man this phenomenon was reported by BENJAMINS.
3. Acoustic reflexes can cause a nystagmus from the cochlea upon the vestibular system. This was experimentally proved in rabbits; the symptoms found in two patients without fistulae and with normal hearing (one patient of BENJAMINS and one patient in our clinic), could be explained in the best way by these facts.

J. GILROY GLASS.

*A New Form of Position Nystagmus.* D. VON DEVIVERE and A. DE KLEYN. *Proc. Nederl. Akademie van Wetenschappen*, 1941, XLIV, 8, 921.

Five cases are described in which a positional nystagmus was elicited by maintaining the head in the lateral position for some minutes and then moving the head to the contra lateral position.

"This position nystagmus showed different forms: once a horizontal, once a rotary, once a vertical and once a rotary-horizontal nystagmus developed while in the last case some vertical movements were followed by some horizontal ones. Of the horizontal and rotary nystagmus the quick component was in three cases directed to the left with patient in left lateral position, and to the right with patient in right lateral position. In one case (patient V) the nystagmus had its quick component horizontally to the left with the patient in right lateral position. In one case an unadulterated vertical nystagmus upwards was found.

"It is very probable that inductive symptoms of SHERRINGTON play an important part in this form of position nystagmus.

"To comprehend this symptom the patients must be supposed to have a 'Bereitschaft' for a position nystagmus when being in a certain lateral position, e.g., in the left one; however, this mere lateral position offers no sufficient stimulation to elicit the nystagmus. If, however, the opposite (right) lateral position by which the irritability of the antagonistic centra is enlarged (induction of SHERRINGTON) is taken first, the changing to the left lateral position accounts sufficiently for the eliciting of a position nystagmus.

# Nose

"All patients showing the above-mentioned form of position nystagmus were females. However, the number (5) was too small to draw conclusions."

Only one similar case was found in the literature, a case described in 1916 by Urbantschitsch. (*Monat. f. Ohrenheilk.*, (1916) 50, 199.)

J. GILROY GLASS.

## NOSE

*The Use and Abuse of Nasal Vaso-Constrictor Medications.* BARNEY M. KULLY, M.D. (Los Angeles). *Journal A.M.A.*, February 10th, 1945, cxxvii, 6.

The writer attempts a reevaluation of the increased use of nasal vasoconstrictor drugs. The primary vasoconstrictor effect of sympathomimetic drugs is usually followed by a secondary vasodilatation. This secondary dilatation is influenced by the type and amount of drug used and the sensitivity of the individual.

Judicious use of vasoconstrictor drugs is indicated in surgical procedures and in some nasal infections, particularly acute sinusitis.

The indiscriminate use of this medication in acute rhinitis lengthens the course of the infection and increases the incidence of sinus and ear complications.

Vasoconstrictor drugs may of themselves produce a vasomotor rhinitis indistinguishable from that due to allergy. Vasomotor rhinitis of allergic origin is aggravated by constrictor medication.

The use of vasoconstrictor drugs in chronic obstructive conditions adds secondary congestion to the obstruction already present.

The addition of antiseptics, particularly sulfathiazole to vasoconstrictor drugs, increases the irritant properties without compensating therapeutic benefits.

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## MISCELLANEOUS

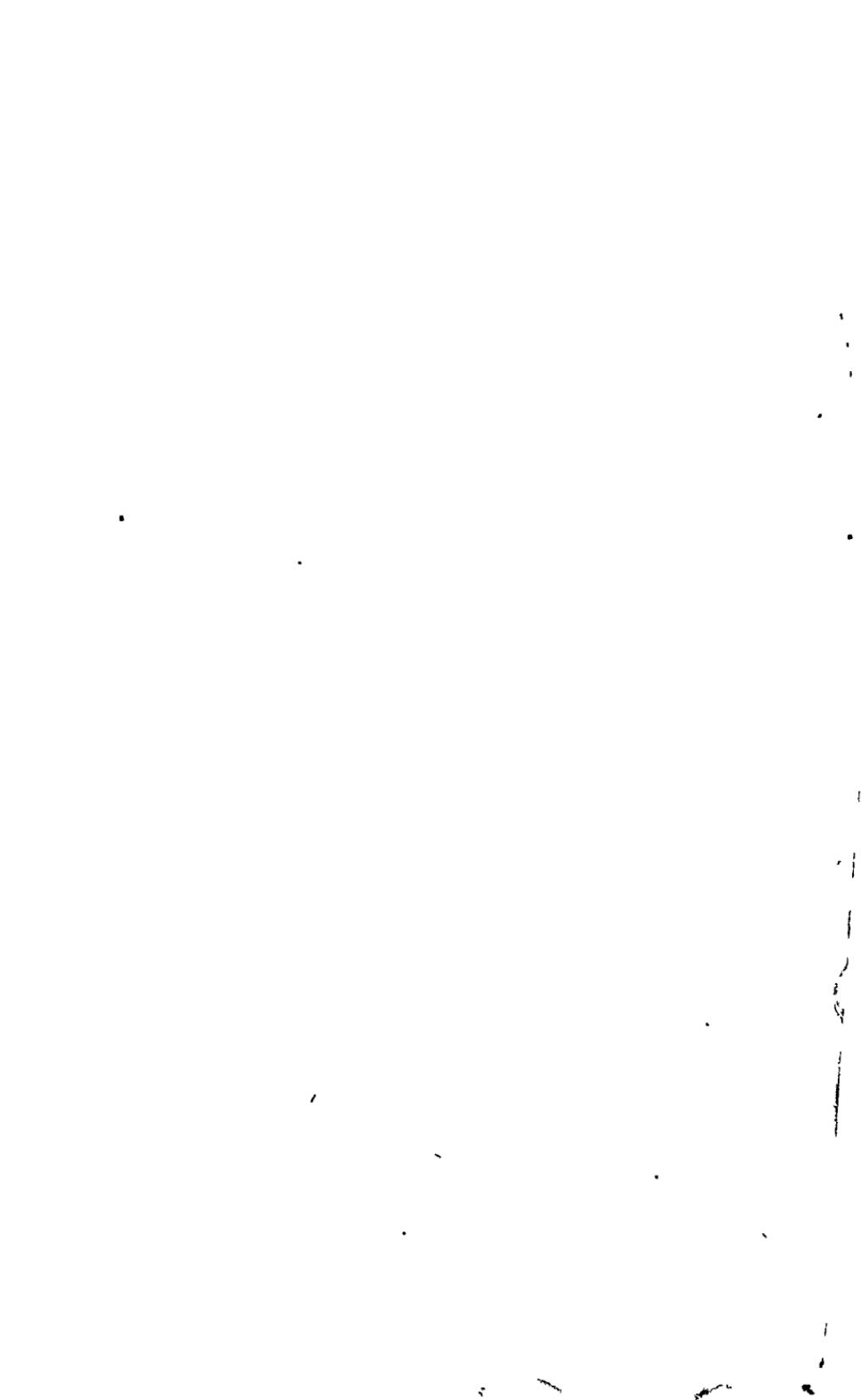
*Local Use of Penicillin in the Ear, Nose and Throat.* FLETCHER D. WOODWARD, M.D., and THOMAS HOLT, M.D. (Charlottesville, Va.). *Journal A.M.A.*, October 27th, 1945, cxxix, 9.

In their study the writers used penicillin lozenges containing 800 units each, solutions containing 500 units per cubic centimetre, and a water soluble jelly containing 1,000 units per gram.

Local use of penicillin has proved helpful in the control of acute and subacute infections of the nose but it has been of no value in the common cold or acute otitis media. The local application of penicillin does not produce any real change in the bacterial flora present in the nose and throat.

No systemic toxic reactions were noted but one patient developed a pronounced dermatitis of the external ear.

ANGUS A. CAMPBELL.



# The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

October 1945

## CORROSIVE INJURIES OF THE CÆSOPHAGUS : WITH PARTICULAR REFERENCE TO THE TREATMENT OF ACUTE COPROSIVE CÆSOPHAGITIS

By TRULS LEEGAARD (Oslo).\*

"THIS is a review of a pathetic condition which is the cause of much suffering and distress to those innocent patients who are in this state because it was not known that lye was a poison."

L. Clerf concludes thus a discussion on the treatment of œsophageal strictures in children caused by corrosive substances.

There are few chapters in medicine which have given rise to more emphatic remarks than that dealing with corrosive injuries of the œsophagus in children.

This is quite intelligible. Anyone who has been faced with the task of having to treat such children can scarcely avoid being affected by the tragedy of the accident.

A. Johannesen recorded in 1899, 140 cases of children poisoned by lye, who in the course of six years were treated in the children's department of the Rikshospital, Oslo, an average of 23 to 24 a year. 60 per cent. of these were under four years, 95 per cent. under seven years old. He concludes his paper: "That these cases of great and unnecessary suffering, and subsequent wretched existence and loss of life arise, is no credit to our society".

\*From the Rikshospital, Oslo, Ear, Nose, and Throat Department. (Director: Professor Frithjof Leegaard.)

# Truls Leegaard

Conditions in the meantime, however, appear to have improved considerably, since the question, to judge from the literature, has only to a small extent engaged the attention of doctors. This is due partly to the fact that the general public is made cognisant of the danger, partly to the legal regulations that exist concerning the keeping and sale of injurious substances.

In the ear, nose and throat department of the Rikshospital, 29 patients in all, with recent corrosive injuries and strictures, were admitted during the ten year period 1933-1942, that is, 2, 3, 2, 5, 3, 1, 4, 2, 4 and 3 patients each year respectively.

Of these 12 were children between 1 and 3 years of age, and 10 were children between 4 and 10 years old.

Since May 1st, 1943, a total of 52 such patients have been treated, 9 in 1943, 20 in 1944, and 23 up to July, 1945. 34 of these 52 were fairly recent injuries, and 30 were children under the age of 3. This is a very significant, indeed unpleasant, increase that has taken place.

It is apparently the increased use of chemical washing materials on account of war conditions that is the cause of this, children's unsatisfied craving for sweets also perhaps plays a rôle. In any case it has forced us to review our treatment of this affliction.

Corrosive injuries of the œsophagus may be seen in patients of all ages. In adults, accidents, carelessness and perhaps most often, attempted suicide are responsible. In children it is due almost constantly to negligence on the part of the relatives.

The geographical situation of countries and perhaps the temperament of the inhabitants appears to determine to some degree the age at which this disease occurs most often. In Bulgaria, Hungary and Slovakia, where writers like Belinoff and Erdélyi can describe their experiences in over 800 patients, it appears that adults are concerned in an overwhelming degree, and in the majority of cases attempted suicide is the cause. In Vienna where the treatment of this disease has been frequently discussed, the problems of age distribution are somewhat variable; but on coming northwards it is chiefly children who are affected by corrosive injuries of the œsophagus. In U.S.A., also, injuries in children are chiefly recorded.

Corrosive injuries may arise from swallowing acids and alkalis, but in the majority of cases the careless use of chemical washing materials, solutions of lye, more rarely caustic soda in substance or washing powders. In some cases I have seen severe corrosive injuries in children who have drunk essence of vinegar, i.e., concentrated acetic acid.

In discussing below the corrosive injuries of the œsophagus, it is particularly the treatment that is the object of my discussion. Before I come to this, however, I shall discuss shortly the symptomatology, diagnosis, morbid anatomy and prognosis.

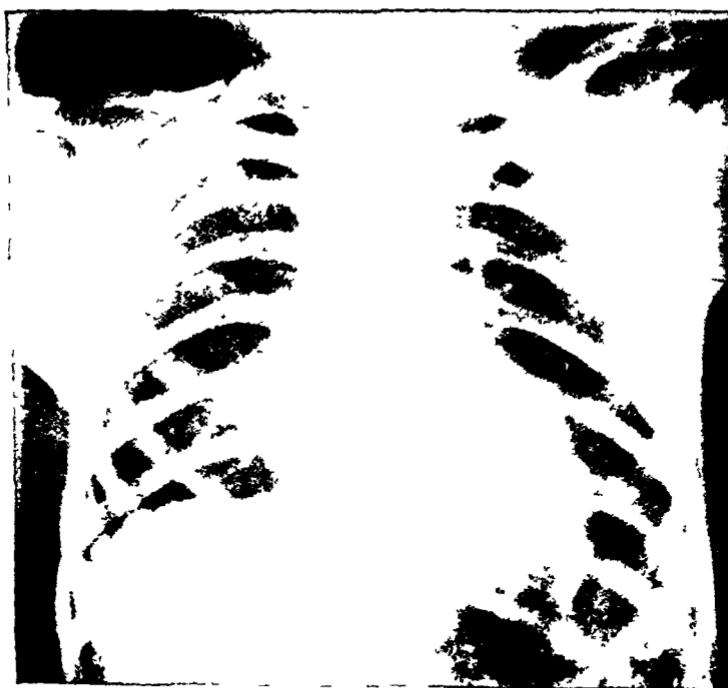


FIG. I

B J X-ray of the thorax, taken 22.9.43, six days after injury Normal findings.



FIG. 2.

B J 14 days after the injury. Considerable increase in width of the upper part  
of the mediastinum

# Corrosive Injuries of the Oesophagus

## Symptoms

Symptoms depend on the concentration of the corrosive substance and on the amount swallowed. A single gulp, especially in children, can produce very severe injuries.

The patients get burning, smarting pains in the mouth and throat. Oedema and injection of the mucosa appears, and eventually white corrosion marks on the lips, tongue, palate and in the throat. Oedema in the laryngeal aperture may cause respiratory obstruction. Difficulty in swallowing appears with marked salivation and vomiting, which may be bloodstained.

Somewhat later pains in the chest, radiating to the back appear, indicating rather a deep lesion of the oesophageal wall. In such cases fever is also seen, which may be very considerable, and other toxic symptoms, with a state of severe generalized exhaustion, which may lead to death in the course of a day or two. In some cases acute corrosive oesophagitis may show serious developments even after the immediate danger is over.

In a deep corrosion of the oesophageal wall peri-oesophageal changes, perforation of the wall, purulent oesophagitis and mediastinitis appear, which may become circumscribed, but which sometimes break through to the pleura and pericardium, producing purulent pleurisy and pericarditis. Rupture into the trachea or bronchi is also seen.

We have recently observed such a development in two of our patients, one of whom died, whilst the other recovered after surgical treatment. I will relate their case histories :

The first was a year-old boy, who, on September 22nd, 1943, 12 days before admission, got hold of a bottle of lye from which he drank. He was immediately given milk to drink, and vomited a couple of times, but there was no blood in the vomit. The doctor who was called said there was nothing to be done.

For the first 8 days he got down fluids without difficulty. He was then tried with bread, vegetables and apples, but this he immediately vomited, whereupon he was admitted to the ear, nose and throat department of the Rikshospital.

*Present state 4.10.43.* the patient looked well, General condition good.

*Oesophagoscopy 9.10.43* (Truls Leegaard), the laryngeal aperture is somewhat oedematous and injected. The oesophageal mucosa is everywhere rather oedematous and injected. At the mouth of the oesophagus there is a little bleeding, otherwise the mucosa is intact down to the region of the hiatus, where posteriorly there is a granulating wound which is almost circular.

A Nélaton catheter No. 21 was then introduced through the nose without difficulty.

Two days later a marked rise of temperature occurred with signs of a

# Truls Leegaard

right-sided pulmonary lesion, massive collapse of the right lung, and some cyanosis. The child died soon afterwards.

## AUTOPSY

The œsophageal mucosa was œdematous and injected in its whole length.

At the level of the hilum of the lung a perforation almost the size of a pencil with a canal which finished up in the right pleural cavity was seen.

There was a communication from the pleural cavity through the diaphragm, just by the hiatus, to an almond-sized irregular abscess cavity between the diaphragm and the fundus of the stomach.

On the right side the pleural cavity contained  $\frac{3}{4}$  litre of purulent fluid. There were no adhesions to the lungs, which lay completely collapsed. The pleural membranes were coated with fibrin. In the left pleural cavity 20-30 ml. of purulent fluid were found, and fibrin coating on the pleural membrane.

The right lung was totally atelectatic. No pus was found in the bronchi. The left lung was markedly hyperæmic and œdematous.

The pericardium contained about 20 ml. of purulent fluid. The membranes were dull with some fibrin flakes.

The upper part of the mucous membrane of the stomach was injected and œdematous.

## AUTOPSY DIAGNOSIS.

*Lye corrosion of the œsophagus. Empyema of the right lung. Total atelectasis of the right lung. Purulent pleurisy on the left side. Pericarditis.*

The second patient was a girl of 1½ years, B.J. 16.9.43, six days before admission, she got hold of a bottle of spirit of sal-ammoniac, and drank some of it. Straight away she vomited a little. Later she had drunk milk as usual. She had not complained of pain. (See also Fig 1.)

The doctor who was called found that it was not necessary to do anything.

The day after, she had a rise of temperature to 39° C, and it was now found that the child had a sore in the mouth. Later she became febrile and for this reason was admitted to the ear, nose and throat department of the Rikshospital.

*Present state 22.9.43, rather pale and thin. She did not look ill. Temperature 38.2° C. Pulse 100.*

On the lower lip there was an area of brownish-grey necrosis, which involved most of the lip and adjacent parts of the gum. The same was seen on the anterior third of the tongue. Greyish-white corrosion plaques were present on both tonsils and on the epiglottis.

24.9.43. *Œsophagoscopy (Truls Leegaard) : considerable changes*

## Corrosive Injuries of the Oesophagus

in the mucosa in the aperture of the larynx with marked swelling and redness were present. In the oesophagus from the mouth of the oesophagus to the cardia, the mucosa was everywhere covered with a corrosion membrane, which in the main was adherent, but in a few places had begun to separate, and had a slightly bleeding surface.

The wall of the oesophagus was everywhere freely mobile and gave no impression of rigidity. A Nélaton catheter No. 18 was introduced through the nose.

The temperature remained raised subsequently between 38° and 38.5°C. It rose, however, further, respiration became somewhat embarrassed and the colour of the skin slightly cyanotic. Moreover, a slight swelling was seen on the neck, mostly on the right side.

X-ray investigation 1.10.43 showed a filling up of the upper part of the mediastinum, a three-cornered shadow with its apex downwards. (Fig. 2.)

Since it was considered that a mediastinitis was present, operation under ether anaesthesia was immediately performed.

Collar mediastinotomy (Truls Leegaard). Incision on the right side of the neck. Beneath the deep cervical fascia a large abscess cavity was entered from which abundant pus under pressure was evacuated.

The oesophagus was seen to be involved in the abscess cavity, and a couple of cm. below the oesophageal mouth the opening of a small perforation was found. The abscess cavity was filled with 2 gr. sulphathiazole powder, and a Morris drain was laid in. In addition, a Nélaton catheter No. 21 was introduced through the nose, and carried down the oesophagus under direct vision.

Treatment with sulphathiazole through the catheter was instituted, and she received a total of 10<sup>3</sup> gr. in the course of 9 days.

The abscess cavity in the mediastinum decreased rapidly in size (Fig. 3), and the subsequent course was without noteworthy complications, except that the retained catheter caused a number of difficulties on account of changes at the glottis.

I shall go into this more closely in the discussions on the treatment of this disease.

If the patient does not die as the immediate result of the accident, the acute symptoms subsequently recede in most cases, the patient is again able to begin swallowing, first fluids, then soft food and often any kind of food. In a great many cases this is, however, a passing improvement. "The victims, or their relatives, and sometimes, sad to relate, the physician, are lulled into a false sense of security that, because there was no immediate stenosis, the danger of stricture had passed," says R. M'Kinney.

After 3-4 weeks the difficulty in swallowing recurs, and the increasing

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after-effects of corrosion produce a more or less severe constriction of the gullet.

In a great many cases the patients, in spite of treatment then suffer trouble for the rest of their lives. Food must always be chewed finely, since even small pieces may stick, particularly pieces of apple, pieces of potato, orange pips, etc. The state of nutrition may suffer because of this, and the resistance to disease may be lowered. It is also a consideration that not a few of these patients die of tuberculosis into the bargain.

Moreover there is the continuous danger of fatal complications, produced by lesions resulting from the passage of bougies and attempts to remove foreign bodies.

## Diagnosis

Diagnosis is usually easy. It may, however, be difficult to determine the localization of the corrosion and how deep it goes.

In regard to localization, it is repeated in a number of textbooks and other papers that the three physiologically narrow places in the oesophagus, the mouth of the oesophagus, at the bifurcation of the trachea and at the hiatus of the diaphragm, are those which are most exposed to the corrosive substance, and that therefore the most pronounced corrosion of the mucous membrane of the oesophagus, as well as strictures, are found most frequently in these situations.

Haslinger's experience is contrary to this in that scar stenoses lie just as often between, as at, the physiologically narrow places.

M'Kinney writes that a scar is often found at the mouth of the oesophagus, but that the stricture lies lower down, frequently in the lower third of the oesophagus.

Such is also our experience. Strictures do arise at the mouth of the oesophagus, but are rare. I give below the localization of the stricture due to corrosion in 30 of our patients, whose case histories contain sufficient relative data.

Oesophageal mouth	2
Between the mouth of the oesophagus and bifurcation	9
Bifurcation	7
Between the bifurcation and the hiatal region	7
Hiatal region	3
Whole oesophagus	2

From this, the lower half of the oesophagus appears to be more frequently attacked than the upper. No special attraction for the physiologically narrow places appears to be indicated in this series.

In order to attempt to get further enlightenment investigations could be made with a substance, which leaves a trace in the same way as lye,

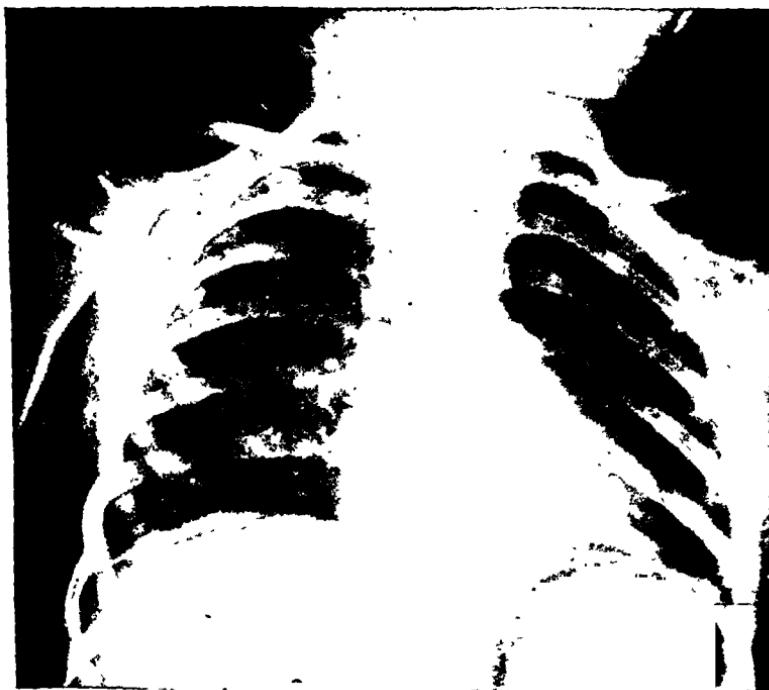


FIG. 3.

B. J. The signs of mediastinitis have very substantially diminished after operation,  
collar mediastinotomy.



FIG. 4

B. J. Permanent tube through the nose.

## Corrosive Injuries of the Oesophagus

but which is harmless. It is not difficult to attempt this with coloured fluids.

For this reason I let 3 patients drink a 3 per cent. aqueous solution of methylene blue and carried out oesophagoscopy immediately after. The investigations gave the following results.

1. A 56 year old woman swallowed 15 ml. of methylene blue solution. There was afterwards marked blue colouring of the lips, tongue and the hard palate, lesser blue coloration of the soft palate and pharynx, *no* blue coloration at the mouth of the oesophagus, feeble blue coloration of the oesophageal wall from the post-cricoid area to the bifurcation, very marked blue coloration from the bifurcation to the diaphragmatic hiatus.

2. A 27 year old man drank 10 ml. of methylene blue solution.

There was moderately strong blue coloration of the tongue, palate and throat.

There was *no* blue coloration related to the mouth of the oesophagus. Some centimetres further down a slight blue coloration began within 30 cm. of the teeth, that is, a little below the bifurcation.

From this position down to the region of the hiatus there was a considerable degree of marked blue coloration.

3. A 61 year old woman drank 10 ml. of methylene blue solution.

Marked blueness of the lips, tongue, palate and throat, rather less marked in the pharynx, was present.

*Slight blueness* of the mouth of the oesophagus, but moderately strong blue coloration from here down to the bifurcation, and more marked blue coloration of the section down to the region of the hiatus was present.

The result of this investigation refutes the former theory that the points of physiological narrowing in the oesophagus are the site of election for corrosive injuries.

It explains the findings referred to above in our brief case material, and likewise the observations of Haslinger and Hoag.

### CHANGES IN MORBID ANATOMY

For the precise knowledge of these changes we are referred to Belinoff in particular.

This author has undertaken investigations partly in dogs, partly with human material.

He investigated 42 dogs, which were killed at varying times after introduction of lye solution into the oesophagus by means of a catheter.

In addition he investigated the oesophageal wall in 60 patients, who had died from drinking lye in the more recent or more distant past.

He found that fibroblasts appeared in the oesophageal wall after 24 hours, and the collagen fibrils derived from them appeared at the end

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of the first week or in the course of the second week. This point of time signifies therefore the inception of scarring. There was firm scar tissue after 3 weeks. The reparative changes in the wall were dependent on the quantity and strength of the lye.

According to the degree of action by the corrosive substances on the wall of the œsophagus Belinoff divides acute corrosive œsophagitis into 3 forms.

1. The very slight and slight cases.
2. Moderately severe cases.
3. Severe cases.

It is only necessary here to mention the purely schematic conception for the sake of the general viewpoint: in reality it is frequently, or rather very frequently, a question of transition forms.

## 1. *The very slight and slight forms.* About 10 per cent. (Belinoff).

In their morbid anatomy the very slight cases are characterized by necrosis of the most superficial epithelial layer. A moderate demarcating inflammation appears, and the stratum corneum is cast off in small strips or in larger flakes.

No scar is produced in this form.

In the mild cases necrosis goes down into the muscularis mucosae, and leaves a superficial scar. These are shaped rather like a furrow (*linear*), a semicircle (*semilunar*) or a circle (*annular*).

## 2. *The relatively severe, serious forms.* About 60 per cent. (Belinoff).

In these necrosis goes down to the submucosa, as far as the tunica muscularis. Practically the whole musculature is infiltrated by thick scar masses from the scarring that is produced here, and the scars embrace the whole circumference. They may be annular (2-3 cm.), or cylindrical (tubular) (5-10-15 cm.).

## 3. *The gross forms, progressing eventually to death.* About 30 per cent. (Belinoff).

Necrosis here comprises the tunica muscularis, and may even extend out to the peri-œsophageal tissue.

A well demarcated zone of inflammation is seen, and the dead areas are finally cast off, and are either swallowed or vomited up. Sometimes the interior of the œsophagus is shed as a continuous tube (*œsophagitis desiccans*).

Separation occurs usually between the 5th and 7th days, but may take place considerably later.

When the corrosion or the demarcating inflammation penetrates outside the œsophageal wall, purulent œsophagitis, mediastinitis circumscribed or diffuse, and eventually pleurisy and pericarditis make their appearance.

Following the acute phase with necrosis and inflammation, the



FIG. 5.

B. J. After treatment. The contrast medium passes easily, good contours to the mucous membrane without definite pathological changes.



FIG 6.

R. B. 1½ years. External Oesophagotomy about one month after the injury  
Treated first by a permanent catheter Symptom free on follow-up 2 years later.

## Corrosive Injuries of the Oesophagus

reparative phase, scar formation, appears, which takes a long time, many months (Treer.)

Above the stricture a dilatation of the oesophagus may thus arise, which often reaches fairly large dimensions.

### Prognosis

The prognosis is not particularly good. The mortality figures vary considerably, however, among the different writers. Von Hacker gives the mortality as 40-50 per cent., Billroth 38 per cent., Belinoff 27 per cent., Erdélyi 20-23 per cent.

In cases of severe corrosion most deaths occur during the acute stage, but also later, patients, who are "cured" with stricture formation, are exposed to constant dangers. In some a poor state of nutrition results in diseases dangerous to life. In all, perforation may follow at any moment as a result of passing bougies. Impacted foreign bodies also bring the danger of complications.

From our scanty material before May 1st, 1943, it is difficult to arrive at the prognosis. A number were transferred to the surgical department for gastrostomy, and a great many came for the first time when the acute symptoms had been overcome.

Of the 52 patients I have personally treated, 6 died subsequently, 2 out of 34 treated in the acute stage, and 4 out of 18 treated for stricture.

The prognosis with regard to the functional result is dependent partly on the degree of action of the corrosive, partly on treatment.

### Treatment

Dilatation of oesophageal strictures has been carried out for several hundreds of years.

At the beginning of this century von Hacker maintained that a recent corrosive lesion in the oesophagus ought not to be bougied and dilated so long as there were signs of ulceration. It was the fear of perforation, of making a "false passage", that was responsible. He would, therefore, wait till 3 to 4 weeks, or sometimes a longer period, had passed before beginning treatment. This method of treatment was the most usual for several decades, and still obtains, in some degree. Von Hacker states that a half of the patients get severe strictures, and the rest mild strictures.

We must agree with Salzer when he says that the consequences of the treatment or lack of treatment are distressing.

*The essential point is to begin treatment before the stricture has appeared,* before scar formation has come into action. It is necessary to prevent the stricture arising, and scar formation must, therefore, be controlled. This was also asserted by O. Borchgrevink in 1899 and later by Bass and Fraenkel. This conception has become gradually more and more general.

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The risk of this early treatment does not appear to be great, judging by the fairly extensive literature which has arisen on this question.

Salzer stated, "Bei Kindern haben wir heute schon die Verpflichtung, die Frübehandlung einzuleiten. Wird diese einmal allgemein durchgeführt sein, dann werden jährlich viele Menschenleben gerettet werden, viel Leid und jahrelang Behandlung wird von den armen Verätzten ferngehalten werden".

In 1887 Gersuny was the first to introduce a retained bougie in the oesophagus for a recent lye corrosion.

O. Borchgrewink (1899) recommended the use of soft bougies before scar formation had begun, and A. Johannesen (1899) used this method in the series of patients he described. Bass and Fraenkel (1907) also spoke favourably of this treatment, and later P. Zachariae (1914) reported the successful result of this treatment in a child 2 years old. Roux (1919) made use of retained catheters inserted through the nose in order to prevent strictures.

All these individual communications do not appear, however, to have led to any general deviation from the old teaching of von Hacker, and credit must be given to H. Salzer, who in 1920 and the years following constantly silenced the opposition to his "Frübehandlung", that a change in the treatment of acute corrosive oesophagitis has taken place.

But even if there is generally speaking unanimity in regard to the advantage of this early treatment, considerable difference of opinion still reigns as to *when* this should begin, and *how* it should be carried out.

Salzer used a soft, hollow rubber bougie filled with lead shot. He stated that this bougie, which was first used by Bass, by reason of its weight glides down the oesophagus almost by itself. He used Charrière No. 30, passed the bougie daily from the second to the seventh day, and allowed it to lie *in situ* for half an hour. After 3 to 4 weeks the case was brought every other day, and after the subsequent 6 to 8 weeks once at indefinite periods. He advised this method in all corrosive lesions, in adults and in children, in that he reckoned to cure 90 per cent. of these patients. The method has had and still has a number of adherents (Bokay, Erdélyi) even if the enthusiasm with which Salzer described it is not completely shared by all. Objections have been raised particularly against beginning at so early a stage, and partly against the daily use of bougies in all, especially the serious types, of lye corrosion.

Lotheissen alleged (1923) that the results were not always so good. In the severe corrosions frequently fever and rigors occur after passing bougies, so that instrumentation must be postponed and then suddenly the stricture appears.

Fraenkel strongly advised against beginning as early as 2 to 6 days after the injury. At this stage there are lacking those factors in morbid anatomy on which the stricture that is to be prevented is based. He

CORROSIVE INJURIES OF THE OESOPHAGUS: WITH PARTICULAR REFERENCE TO THE  
TREATMENT OF ACUTE CORROSIVE OESOPHAGITIS—TRULS LEEGAARD



FIG 7

R B 1½ years X-ray of oesophagus 4 months after drinking of lye. Treated by external oesophagotomy

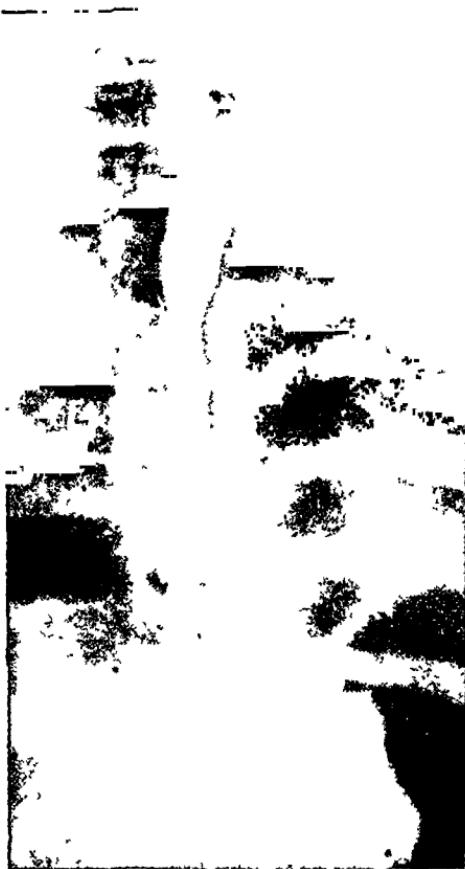


FIG 8

E M 3 years Before treatment The contrast medium passes comparatively easily, and there is some peristalsis The contour is unevenly frayed, an indication of ulceration of the mucous membrane.

## Corrosive Injuries of the Oesophagus

considers the end of the second week after the injury is the favourable time.

Even Erdélyi who warmly advocated the progressive measure of Salzer stated that in severe cases instrumentation cannot be carried out daily, and that then a stricture arises.

"Even if instrumentation proceeds ever so gently, an irritation of the corroded surface is always produced."

Belinoff is perhaps the one who in recent years has occupied himself mostly with this problem. He has for several years used the method of Salzer, but could only in part substantiate the good results, chiefly in mild cases.

On the basis of his investigations in morbid pathology to which I have earlier referred, he considered that treatment with bougies ought to begin after 7 to 10 days, as a rule in the beginning of the second week, when the collagen fibres, the basis of scar formation, first appear, and it is these which should be worked on and partly developed, so that the lumen of the oesophagus becomes sufficiently wide and acquires a regular shape. Scar formation cannot be hindered, but it can be controlled.

But he maintained in recent years, however, that daily instrumentation is dangerous.

A number of the patients die from this treatment, by perforation and other complications.

The daily passing of sounds traumatizes the corroded wall of the oesophagus, and reaction, bleeding and oedema, occur readily, which leads to the formation of a thick scar.

Hoag held in 1937 the same viewpoint.

This undesirable reaction with oedema and increasing stricture phenomena is probably an experience that many have had, even after careful instrumentation. For this reason we have been forced to perform gastrostomy in several of our patients.

Belinoff, therefore, considered that a rational treatment of acute corrosive oesophagitis cannot be carried through before an indication of the nature and extent of the corrosion has been obtained. To obtain this knowledge he advocated early oesophagoscopy, that is, after the end of the first week.

He maintained that the risk, where the insertion occurs under direct vision, is little or nothing, compared with blind instrumentation. He performs the oesophagoscopy without anaesthesia.

In the 34 patients with recent corrosive lesions of the oesophagus whom we have had under treatment during the past year I have in all cases performed oesophagoscopy after the end of the first week. In children it is carried out under ether anaesthesia, to avoid the risk of producing muscular contractions, or entirely without anaesthesia, and in adults under local anaesthesia.

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Reactions have not occurred in consequence of the interference, and the investigation has in a high degree facilitated the estimation of the grade of corrosion which has taken place.

Consideration of the past history is shown actually to be of little value, and the clinical symptoms, when they are not merely due to severe toxic conditions, give no sure tangible facts.

Precisely as Belinoff maintained, it is important, whatever form of treatment is used, in no way to irritate the corrosion, bearing in mind the classification which is given on page 399 and subsequently.

Treatment ought in fact to be varied.

There appears to be agreement that in the mild forms of corrosion instrumentation according to the method of Salzer achieves its objective in the majority of cases.

When it is a question of serious, and possibly severe corrosion injuries several writers (Belinoff, Hoag) assert that, in the same way as with other diseases it is necessary that the diseased organ obtains rest. It must be spared the traumatization of daily instrumentation, and it must be spared the swallowing of food, which produces and maintains a secondary inflammation, and readily causes spasmotic muscle contractions.

Belinoff and later Hoag have, therefore, proposed that a retained catheter shall be used, such as Gersuny used almost 60 years ago.

This "bougie à demeure" must not be so thick that it exerts any pressure on the wall of the oesophagus, and there should then be no pressure sore, an objection which has formerly been held against this method of treatment (Weinlechner, Kermauer). Dohlman has recently described a case where a pressure sore arose corresponding to the mouth of the oesophagus. We have ourselves noticed in 3 or 4 patients after a varying time, most frequently 2 to 4 weeks, that audible expiration appears, and on investigation we have then found oedema in the laryngeal aperture, and a superficial ulceration on the posterior aspect of the arytenoid region. The catheter is then removed, and treatment continued either by the daily use of bougies, or by the operative treatment described below. We have not seen any lasting injury from the retained catheter. Hoag also maintained that any canal through soft tissue has a tendency to dilate spontaneously if a soft rubber catheter is constantly passing through it. This is a fact that may be observed in disease of other hollow structures, and in regard to the oesophagus we have many times had the opportunity of verifying this in our patients. It is particularly the case in strictures where the scar formation is not mature.

Gersuny (cited by Belinoff), Roux and Hoag carried the catheter down through the nose. Hoag used the customary Nelaton catheters. Belinoff at first used a special catheter, which was passed down through the oesophagoscope, and whose upper end lay in the hypopharynx, anchored by a silk thread. Since the catheter readily produced

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undesirable reflexes and the thread frequently broke, he proposed in 1940 that in the serious forms of acute corrosive oesophagitis an *external oesophagotomy* should be made and the catheter introduced by this means.

The catheter, which is moved twice a week, may be left in a week at a time, and the oesophageal wall can be inspected through a Killian's speculum.

He further asserted that this manoeuvre has moreover the advantage that it may at the same time be regarded as a collar mediastinotomy, and by the drainage produced prevent the development of a mediastinitis. He had carried out this operation in 5 cases in all.

It has been objected by Erdélyi that the upper end of the oesophagus, which as frequently reported is exposed to the action of the corrosive, is not treated by this method.

Belinoff recorded that he has used 2 catheters, one leading downwards and a short one leading upwards.

There is in addition the circumstance, which I mentioned earlier, namely, that a corrosive lesion involves the actual mouth of the oesophagus in all probability very seldom. It has been declared that in the act of swallowing the mouth of the oesophagus opens so completely that there is no narrowing at this situation. The objective will then be reached by placing the opening into the oesophagus very high up, which is not technically difficult even in small children.

Stasis of saliva and pharyngeal secretion does not arise to any great extent, either from this interference or from passing a catheter down through the nose. The retained catheter *must* not be of such a calibre that it completely fills the lumen of the oesophagus.

I shall hence discuss how our view of the treatment, especially in the acute condition, has been formed on the basis of our experience during the last two years, when in the course of a relatively short space of time, we have treated 34 recent lye injuries of the oesophagus.

In spite of all that is written by the many who have had hundreds of such patients under treatment, I consider that actual personal experience with material, comparatively limited as it is, is of a certain value, and that it is accordingly justifiable to set it forth.

I wish immediately to point out that the treatment, as previously stated, is dependent not only on how severe the action of the corrosive has been, but also to a high degree on the age of the patient, as in my opinion an absolute differentiation must be made between adults and older children on the one hand, and small children in the first years of life on the other hand. In the latter, that help on the part of the patient which is necessary, so that the passage of the soft catheter can be undertaken without substantial risk, cannot be counted on.

In addition "the picture of an acute corrosive oesophagitis is so variable by reason of differences in localization, the natural disposition

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of the patient and the individual tendency to healing, that any dogmatism is misplaced. In the one case, one line of treatment, in the other case, another line of treatment is the appropriate one" (Erdélyi).

It is stated that in corrosion by alkaline materials acid solutions should be given, e.g. citric acid or weak vinegar. In corrosion by acids, alkalis should be given, e.g. effervescing magnesia.

The patient must be kept in bed, and ought to be admitted to hospital immediately. It has twice happened to me that parents have come to the department with their children who have just drunk lye and have been told to come again a week later, but have not returned. It is to be feared moreover that we see such patients at a later, and from a therapeutic point of view unfavourable, period.

The patient's diet at this period consists of copious fluids, milk, soup and porridge.

A week later œsophagoscopy is performed, by which in combination with the clinical symptoms an opinion is formed of the nature of the case and how the treatment should be conducted.

I have not seen in any case untoward events from this early œsophagoscopy, and it undoubtedly gives valuable information.

In adults and older children I use only light anæsthesia of the pharyngeal mucosa, in small children œsophagoscopy is carried out either under ether anæsthesia or entirely without anæsthesia. Since the whole investigation lasts a very short while, I have deemed it quite justifiable to carry out œsophagoscopy in this way with small children, even if respiration becomes a little embarrassed. Pressure of the endoscopy tube will indeed in small children produce compression of the soft cartilaginous rings in the trachea. In prolonged investigations, or treatment, e.g. of strictures, it is necessary to carry out the investigation under intratracheal anæsthesia.

So far the treatment is simplest in adults and older children. Here in the mild and fairly mild cases the object is achieved, that is a stricture is prevented from arising, by the daily passing of soft bougies, such as Salzer has described. Following Belinoff I have, however, not commenced instrumentation before the second week.

I have used in adults the customary soft stomach tube, Charrière No. 30, and in children up to 12 years old a Nélaton catheter with a calibre rising from 20 Charrière to No. 30. The patient sits with the tube in for 20 to 30 minutes. Instrumentation is repeated daily for 3 to 4 weeks, thereafter every other day for 4 to 6 weeks, and for a period of about  $\frac{1}{2}$  year once a week. Subsequently the patients ought to be controlled at not too long intervals for an appreciably long time, several years. Just as Belinoff writes: "We know when the illness begins, but only God knows when it ends".

In the very serious cases, where the corrosion goes deep down into

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FIG. 9

E.M. 3 years After treatment Normal passage of contrast, good peristalsis, and normal contours to the mucous membrane



FIG. 10.

L. H. 1½ years. Marked stricture in the lower half of the oesophagus. The shadow of the mucous membrane is irregular. Contrast medium passes slowly.

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the oesophageal wall with peri-oesophageal changes, and will in all likelihood lead to a considerable formation of scar tissue, external oesophagotomy ought to be carried out at an early period with the introduction of a retained catheter, following the method of Belinoff.

When children in the first years of life are concerned, it is regularly observed that on attempting to pass bougies they cry, and resist as much as possible. I have, therefore, *in the mild forms* of corrosion passed a soft Nélaton catheter down through the nose. It goes easily as a rule in between a couple of cries. I have used a catheter as thick as is possible, having regard to the nasal cavity. In no case has there been evidence of bleeding or indications of other lesions.

The rubber tubes can remain in for several weeks at a time. They are bent up and fastened by a band round the head. They do not appear to worry the patients. The administration of food also goes very easily, and we have noticed that the children find it easier to get on by this method of feeding than when they have to attempt to feed themselves.

In such cases intubation ought to be continued for at least 8 weeks, and the catheter is changed a few times in the course of this period. Afterwards the patient is kept under observation for some time. When the corrosive injury is *relatively* slight, the retained catheter through the nose is used for 1 to 2 weeks, thereafter continued with daily passing of soft bougies.

The following is a typical case history.

A girl 1½ years old, the day before admission to the department, drank a draught of lye. She was sick a number of times afterwards, was a little out of sorts and had a rise of temperature to 39° C the following day.

On admission the temperature was 39·6° C. Small corrosion marks were present on the lips, tongue and the mucous membrane of the throat. The next day, the temperature was normal, and did not rise subsequently.

8 days later *œsophagoscopy* (Truls Leegaard) was performed. 10 to 12 cm. from the teeth, i.e. between the mouth of the oesophagus and the bifurcation, there was œdema and injection of the mucous membrane with a whitish coating for a limited area involving almost the whole circumference. Below there was no sign of corrosion as far as the cardia.

A Nélaton catheter No. 17 was introduced through the nose.

After the catheter had been changed once, *œsophagoscopy* was again performed 4 weeks after the corrosion: 12 cm. from the teeth a slight constriction of the lumen was seen, where a diaphragm-like fold jutted out.

A catheter was again introduced, which remained in almost 4 weeks (changed once). Oesophagoscopy now showed no appreciable narrowing of the lumen. X-ray investigation with contrast medium gave normal findings. The child ate all sorts of food without difficulty. The general condition was good, and the increase in weight was 2 kg. during her stay.

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On follow-up 1 month after discharge, 3 months after the injury, a small fold of scar tissue could be seen 12 cm. from the teeth. There was no difficulty with feeding.

This was one of the first patients I treated. The calibre of the catheter introduced ought to have been larger. No. 21 would in all probability have gone down, and the period of treatment has it is true been of very short duration.

When severe corrosive injuries are present, an external oesophagotomy ought to be done and a catheter introduced and retained.

The manœuvre acts, as Belinoff states, as a drainage of contingent infection in the peri-oesophageal tissue.

The operation is not difficult to carry out, even in small children. It is done under general anaesthesia in children, and under local anaesthesia in adults. The vessel sheath is retracted laterally, the small neck muscles and the thyroid medially. The muscle mass corresponding to the mouth of the oesophagus is then clearly seen, and the incision may thus be made downwards in the oesophageal wall, between two fixation sutures. We have found it helpful to pass a soft bougie through the nose and then cut down on to it. It ought also to be kept in mind that in children the dome of the pleura extends high up, so that injury to it is to be avoided. The bougie that is introduced must slide down easily, without obstruction. A channel rapidly forms, through which the catheter is easily changed. I prefer to wait 10 days before changing the catheter for the first time. Later it is changed once a week, by this means increasing the calibre up to Charrière No. 30. The dressing must, however, be changed daily, since in children considerable quantities of saliva leak out. Adults remain drier because they spit it up.

Belinoff states that the catheter should stay in "several weeks". I have allowed it to remain in for 9 to 10 weeks, and have then introduced a Nélaton catheter through the nose, if the fistula has not closed in the course of a couple of days. I have not seen a fistula persist for a long or relatively long period.

Subsequent control ought naturally to be long, at first weekly, later less often. Where this has been possible, I have followed up the patient for about a year.

On page 392 and the following pages I have related the case history of a girl 1½ years old with a very widespread corrosive lesion with deep necrosis, which led to a perforation and a circumscribed mediastinal abscess. She wore a catheter through the nose, which she retained for 2-3 months. (Fig. 4.)

I month after removal of the catheter, X-ray investigation (Fig. 5) showed a normal condition, with normal mucous membrane shadow, except for a slight convexity corresponding to the opening of the perforation. The contrast medium passed without hindrance.



FIG. II.

L H After treatment. The contrast medium passes with good speed, but is held up a little in the upper half. The stenosed section is smooth-walled, but considerably wider than before.

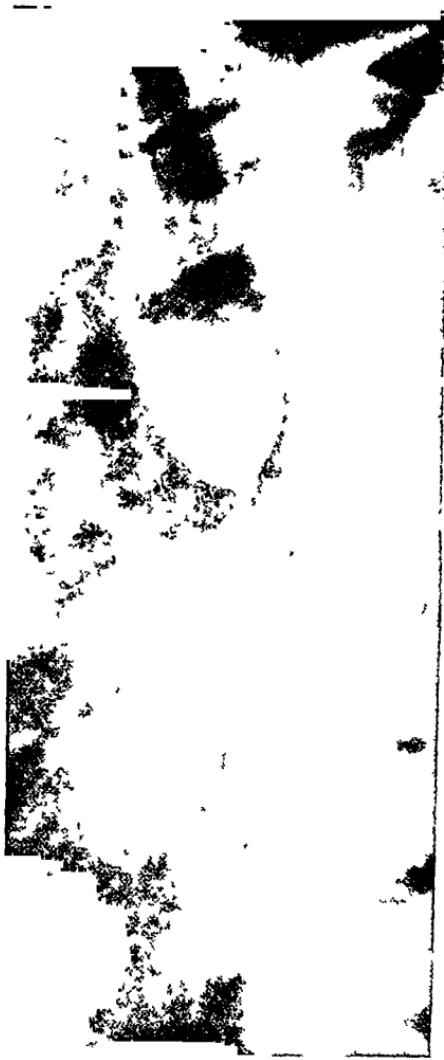


FIG 12

A H 21743. Marked stricture of the lower  $\frac{2}{3}$ rds of the oesophagus, with irregular shadow, presumably ulceration, bobbin shaped dilation with retention proximally

## Corrosive Injuries of the Oesophagus

Because of oedematous changes at the aperture of the larynx it became necessary to use a Nélaton catheter smaller than that which would pass through the nasal cavity.

Without doubt it would have been a better method of treatment to have made an external oesophagotomy at an early stage. In all probability mediastinitis would then have been avoided, and the management of the patient would have undoubtedly been easier.

I shall relate the case history of the first patient on whom I did an external oesophagotomy.

A boy 1½ years old drank lye a couple of hours before admission to the department. He vomited a bit afterwards and salivated markedly.

On admission the temperature was 39°C. There were marks of corrosion on the tongue and in the throat. He was somewhat out of sorts to begin with, but after a couple of days he was afebrile and swallowed fluids and porridge.

8 days later: *Oesophagoscopy* (Truls Leegaard). From the mouth of the oesophagus and extending at least 10 cm. downwards there was a white coating over the whole surface. On separating this, it bled freely. The lumen was of normal size.

It was presumed that a corrosive injury of considerable degree had occurred, with the prospect of severe scar changes. A Nelaton catheter, No. 18, was introduced through the nose.

Almost 3 weeks later *oesophagoscopy* was repeated. The lumen was still fairly roomy. The endoscope which was about 8 mm. in diameter passed easily. *The greater part of the wall of the oesophagus was now a granulating surface wound*, which bled easily.

In order to be able to use a catheter of adequate calibre for retention, the following procedure was, carried out under intratracheal ether anaesthesia:

### *External Oesophagotomy* (Truls Leegaard).

The oesophagus was exposed on the left side, and was incised immediately below the cricoid cartilage. The mucosa was smooth and white.

A No. 27 Charrière catheter was first passed down, but as it fitted rather tightly, it was withdrawn, and with the catheter a small piece of tissue followed (microscopic investigation of this showed connective tissue and a few remnants of smooth musculature, with subacute inflammation).

A No. 24 catheter was, therefore, passed down, which went smoothly. The wound cavity was filled with 2 gr. sulphathiazole.

During the first days after operation the patient was rather ill, in part from difficulty in respiration. X-ray investigation showed that a small pneumothorax had occurred on both sides, with limited atelectasis of the right upper lobe.

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The symptoms disappeared in a short time, and the subsequent course was without any particular complications.

The catheter was changed twice a week. After two weeks it was evident that the lumen of the œsophagus had become larger, and for that reason a larger catheter, No. 26, was used. Subsequently it was possible after a few weeks interval to increase the catheter to No. 28 and No. 30, which was then very freely movable in the lumen.

The catheter through the œsophagotomy was removed after 1 month, that is, just 9 weeks after the lye corrosion. At the same time a No. 21 Nélaton catheter was introduced through the nose, and the fistula in the neck then closed in the course of a week.

The child's general condition was very good the whole time, and the management of him was easier than in the other cases. He increased considerably in weight (Fig. 6). He is now quite symptom free—2 years later. The scar is not particularly disfiguring. X-ray investigation of the œsophagus 4 months after injury gave the following result : " Thick as well as thin contrast gruel passes through the œsophagus without difficulty and without hold up. The œsophagus in its whole length appears to have an almost normal calibre, with supple and even contours everywhere. The shadow of the mucosa appears normal. The calibre shows a distinct change in the different views. The contours are remarkably smooth. Result, *negative findings*". (Fig. 7.)

In this case it would have been preferable if œsophagotomy had been carried out at an earlier stage, in the course of the second week after the injury.

The good experience we had with this patient encouraged us to use the same treatment in subsequent suitable cases, both in children and in adults.

I have since carried out external œsophagotomy fifteen times in all, in 12 children and 3 adults. 2 children died after the operation. The results will be considered later.

*I do not hesitate to say that this surgical interference is a significant turning point in the treatment of this serious disease,* and I am going to discuss shortly yet another such patient.

A girl, 3 years old, E.M., drank two gulps of lye 14 days before admission to the department, 29.8.44. For the first 8 days she lay in bed with fever, becoming later afebrile. To begin with there was constant vomiting, with blood, but later she was able to get down fluids, but not solid food.

31.8.44, *Œsophagoscopy.* The changes began 5 cm. down from the mouth of the œsophagus, and increased downwards in the form of larger or smaller, partly confluent, ulcerations, covered in part with a necrotic incrustation. X-ray investigation showed the same picture (vide Fig. 8).

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FIG. 13.

A H. 8.12.44 After treatment. The contrast medium passes easily, but is somewhat held up above the lower  $\frac{1}{3}$ rd of the oesophagus, which is moderately constricted.



FIG. 14

R T 12 years old Considerable constriction of the lower half of the oesophagus with retention above In the middle of the dilated section there is an eccentric constriction

## Corrosive Injuries of the Oesophagus

1.9.44, *external oesophagotomy*. Very moderate temperature reaction ( $38.3^{\circ}\text{C}$ ). The catheter, which was increased in calibre from 22 to 30 in the course of 4 weeks, was removed after 2 months, and the fistula closed in less than 24 hours.

11.11.44, *Oesophagoscopy*. The wall was everywhere soft and supple. No apparent scar or sign of stricture was seen, but the mucosa in the lower half was thin and bled easily. X-ray investigation: normal condition: (Fig. 19). Bougie No. 30 was passed twice a week for half a year, later less often.

12.6.45. Follow-up. She eats everything possible without difficulty, even raw potatoes and carrots.

It has happened on many occasions that we have had patients admitted about a month after the lye has been swallowed. The chances of a good result when treatment begins at this stage, as was the custom formerly, are considerably reduced, but with perseverance and patience much may be achieved, and very often there is some return for the struggle. Never give up!

I have used the method of the retained catheter also in these patients, and in several cases with good result. In some cases I have also performed external oesophagotomy, once as late as 9 weeks after the injury, with astonishing result. Two examples: the one patient was a  $1\frac{1}{2}$  years old girl, who had drunk lye 1 month before admission. She had increasing difficulty in swallowing and finally was not able to drink, for which a gastrostomy had to be performed in a provincial hospital.

The patient was thin and white. On X-ray investigation a stricture 6 to 7 cm. long from the bifurcation downwards was shown (Fig. 10).

On oesophagoscopy a constriction was found 13 to 14 cm. from the teeth, which lay centrally in the lumen and allowed the passage of a No. 12 bougie.

It was now carefully stretched to the size of No. 16 and oesophagoscopy was then carried out under ether anaesthesia. The upper opening of the stricture being brought into view, with the help of a laryngeal spatula, a Nélaton catheter No. 16 was carried through the nose and down through the stricture under direct vision. After this had been in 12 days, it was removed, and now it was possible to introduce a No. 21 catheter without difficulty.

On X-ray control the lumen was considerably wider and smoother, and the barium gruel passed very rapidly (Fig. 11).

The continuous dilatation was in this case considerably more effective than the intermittent dilation, and in so small a child it was without doubt considerably more gentle.

In the second patient the result was quite favourable. The patient was a 10 year old boy, who 1 month before admission had taken a drink from a bottle of lye. Somewhile after he was treated with bougies, but

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had very great difficulty in swallowing, it was only with difficulty that he could drink.

On X-ray investigation on admission to the department, a pronounced constriction from the bifurcation and for some 10 cm. downwards was found. The shadow of the mucous membrane corresponding to the constricted section was markedly irregular, the contours were crenated and irregular. Slight dilation of the oesophagus above the strictures was present (Fig. 12).

*Oesophagoscopy* substantiated the X-ray findings, and 18. to 19 cm. from the teeth a concentric constriction of the lumen was found, which at its narrowest point allowed the passage of a No. 16 bougie. Slight bleeding followed the instrumentation, and the wall felt markedly uneven,

After a number of attempts the opening of the stricture was brought into view with the help of a laryngeal spatula some days later, and thereupon a No. 16 catheter was led down through the nose and through the stricture under direct vision.

He remained with the catheter through his nose for 2 months, whilst the calibre was gradually increased to No. 20.

During this time he had been very well and put on weight. After removal of the catheter he was able to eat soft food and white bread, but had difficulty with other food. After 1½ years of almost continuous treatment, partly with a retained catheter, and partly by treatment with bougies, he could now eat ordinary food when it was well chewed, and the oesophagus allowed the passage of Charrière No. 24. This was also controlled by follow-up 1/2 year after completion of treatment, 2 years after he had drunk the lye. (Fig. 13.)

It is probable that this patient will have symptoms of stricture the whole of his life. It can scarcely be doubted that this could have been prevented by really early treatment.

A few authors (e.g. Bass) comfort themselves that when the child grows, the lumen of the scar stricture also grows. It is difficult to explain how this is possible. In two of our patients, whom we have had the opportunity of following up for several years, indeed the opposite occurred. In a 9 year old boy the calibre of the bougie fell from No. 12 to No. 7 in the course of 2 years and he finished up with a gastrostomy. In a 5 years old boy the lumen passed a No. 12, but only No. 11 5 years later.

The treatment of stricture when it is already established I shall only discuss quite shortly here.

Dilatation with bougies in these cases is almost our only refuge.

Von Eiselsberg and later von Hacker recommended gastrostomy in gross strictures, and retrograde instrumentation with bougies. With the assistance of a silk thread passed from above as a pilot sound, dilatation was carried out with increasingly thick bougies, "Sondierung

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ohne Ende". Otherwise the commonest method has been to dilate with bougies which are introduced through the mouth, either blindly or by means of the oesophagoscope. The increase in calibre of the bougies ought to progress very slowly, since otherwise a reaction on the part of the mucous membrane is obtained in the form of oedema, and possibly increased formation of connective tissue.

Before beginning treatment with bougies, as good a conception as possible of the nature of the stricture ought first to be obtained in all cases, by the help of X-ray investigation and oesophagoscopy. By this means the risk to which the patients are exposed during treatment is certainly diminished, the formation of diverticula and eccentrically placed strictures, and possible multiple strictures are diagnosed.

Skoog has recently discussed how in such cases obstructions to the passage of bougies, bands of scar tissue and the formation of folds may be removed by the help of diathermy with good effect.

In one of our cases this was carried out with a very good result.

The patient was a 10 years old boy who 5 years earlier had drunk a solution of caustic soda. He came into the department for the first time 2 years after the injury, and was then only able to swallow thin fluids. He was greatly emaciated, and under weight.

It was not possible, even with the oesophagoscope to pass the thinnest bougie through the stricture which was placed eccentrically. Gastrostomy was, therefore, performed in the surgical department with retrograde stretching. This, however, was unsuccessful, but during the time he had his gastric fistula, about 3 months, the lumen of the stricture became somewhat wider, and afterwards he was able to eat better than before, and on oesophagoscopy a No. 22 bougie passed.

Subsequently, however, the passage became narrower again, he lost weight, and was readmitted to the department 3 years later.

*X-ray investigation* showed a considerable constriction of the lower half of the oesophagus, and above this a short dilated section. At this point there appeared a fairly short eccentrically placed constriction, and above this the oesophagus was widened almost like a diverticulum (Fig. 14).

*Oesophagoscopy* (under local anaesthesia) showed marked dilatation of the upper part. 15 cm. from the teeth behind and to the right a fold was found jutting out almost like a small epiglottis. The lumen passed a No. 8 bougie.

Some days later oesophagoscopy (Truls Leegaard) was repeated under local anaesthesia and the fold was divided by diathermy.

There was no reaction after the operation. He was already eating considerably better some days afterwards, and following 1 month's treatment with bougies, by which a calibre of No. 21 Charrière was reached, he was able to eat bread, fish and potatoes. His weight increased rapidly..

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X-ray control showed that the uppermost stricture with the projection resembling a diverticulum had disappeared, and there remained a moderate funnel-shaped dilatation, whence the somewhat constricted oesophagus continued (Fig. 15).

## Personal Material

In conclusion I give a short account of the patients I have personally had under treatment and of whom a series have been followed up 2 years after the injury.

As stated a total of 52 patients have been treated, of whom there were 34 patients with the diagnosis of *acute corrosive oesophagitis*.

These patients were admitted immediately after the injury or a short time after, at most 2 to 3 weeks.

28 were children under the age of 3 years.

1 mentally defective boy eleven years old.

5 adults: 2 men and 3 women (attempted suicide).

The recent corrosive injuries were divided into 3 groups:

### 1. *The relatively slight or mild forms.*

Necrosis of the most superficial epithelial layer, with the possible involvement of the muscularis mucosae is present. Scar formation, superficial or absent, frequently as a linear, semi-lunar or annular scar.

This group comprises 18 patients (17 children). 6 received *no treatment*, and have been symptom-free since.

8 were treated with daily intermittent bougies. All these 8 were followed up and are symptom-free.

4 were treated with retained catheters, and subsequently by intermittent instrumentation with bougies. All these are likewise symptom-free.

### 2. *The moderately severe, serious forms.*

Necrosis goes down to the submucosa. Most often there are confluent extensive wound surfaces with a thick necrotic membrane which afterwards is shed. Without treatment the wall becomes infiltrated with thick scar masses, which involve the whole circumference, the scars become annular or tubular.

This group comprises 10 patients (8 children). 2 patients on whom external oesophagotomy was performed are still under treatment. 6 were treated by external oesophagotomy.

All are clinically symptom-free, i.e. they can eat all kinds of food without difficulty, and without regard to how they eat the food. In 4 no definite changes are visible endoscopically, whilst in 2 there are slight, barely noticeable circular scar changes.

1 patient was treated with a retained catheter through the nose: clinically and endoscopically symptom-free a year later.

1 adult man was treated by the method of Salzer, and is also clinically and endoscopically symptom-free.



FIG. 15.

R. T. After diathermy. The dilatation is considerably less and the ring constriction has gone. The constriction in the lower half is less pronounced. Function greatly improved



FIG. 16.

## Corrosive Injuries of the Oesophagus

### 3. *The severe forms, eventually progressing fatally.*

Necrosis goes so deep, and is so widespread, that severe general symptoms and evidence of peri-oesophageal changes appear.

This group comprises 4 patients, of whom 2 are dead, both from mediastinitis rupturing into the pleural cavity. In one case external oesophagotomy was done.

The two other cases were followed up until 1 year after the injury; and were then clinically, skiographically and endoscopically symptom-free. One, who got mediastinitis and is mentioned previously, was treated by a retained catheter through the nose. The other was treated by external oesophagotomy.

It is somewhat striking that in those patients who have become symptom-free the oesophagus, both on X-ray and endoscopic investigation, appears completely or almost completely normal. Some scar formation there must be, but its form and extent is, however, of a kind that apparently plays no rôle in the function of the injured oesophagus.

This extremely favourable result I believe must be ascribed to the initiation of treatment at a sufficiently early period, and the favourable action of the permanent catheterization by which the oesophagus gets the necessary rest.

Our experience, as the remainder of the material shows, also confirms that the results of treatment are less favourable when patients come under treatment later.

But treatment carried through energetically and patiently can achieve much, even here. It takes time, however, up to a couple of years. In this group also I have seen the very good effect of treatment with a permanent tube, either by a tube through the nose, or, in a number of selected cases, through an external oesophagotomy.

### Strictures of the Oesophagus

This group comprises a total of 18 patients (14 children). Three of these had long standing strictures which were intractable, and are, therefore, not considered here.

One was an 8 years old stricture, which was considerably improved after diathermy of a fold of scar tissue (mentioned previously on page 409).

The remaining 14 patients had swallowed a corrosive substance from 1 (8 patients) to 4½ months before admission.

One is still under treatment.

One emaciated patient, 2 years old, with a narrow stricture (Charrière No. 8) was taken away from hospital before treatment was started. She died 3 months later following an attempt at dilatation in her home town.

One patient, 15 months old, with poor general condition and severe

# Truls Leegaard

scar changes in the œsophagus, died 14 days after an attempt at dilatation. At autopsy a fibropurulent pleurisy and an abscess below in the posterior mediastinum was found, but no detectable perforation.

I. One patient was treated by passing semi-rigid bougies for 2 months.

A year later the mother writes that he eats all kinds of food without difficulty. Before treatment he could only manage fluids.

II. Seven patients were treated by a permanent tube through the nose for a variable time, and dilatation with semi-rigid bougies for a long time afterwards.

Three patients are clinically and endoscopically completely symptom-free.

Three patients had on subsequent investigation slight indications of stricture or scar changes, but two of them could eat any kind of food without difficulty.

One patient (mentioned previously on page 410) had rather more pronounced symptoms, but also now manages well.

III. Three patients were treated by *external œsophagotomy*. In two, after a period of treatment with a permanent tube, slight signs of contact ulceration in the post-cricoid region appeared, and they were, therefore, submitted to operation. Both these patients who had severe scarring in the œsophagus died from mediastinitis. The third patient afterwards had only a very slight stricture endoscopically. She must take care with raw carrots, but otherwise eats all kinds of food.

Of the patients whom it has been possible to follow up, a total of 44 in the first group, *acute corrosive œsophagitis*, 26 are cured, 2 are very much better, and 2 are dead. In the second group, *stricture of the œsophagus*, 3 are to all intents and purposes cured, 7 are very much better, 1 unchanged (died later), and three are dead.

## Summary

In this paper the collected material from Norway for the past 45 years is shortly discussed, and is compared with the decrease in frequency that a collection of the material of the last ten years appears to show, in view of the fact that there has been, however, a noteworthy increase since the year 1943.

The frequency of this disease appears moreover to increase the further south and east in Europe that one comes.

It records the usual symptoms, which do not always correspond to the serious character of the affliction. In this connection the case histories of two patients are given. They were children in whom the disease took a dangerous turn, and ended fatally in one of the cases.

The *diagnosis* is further discussed, and an attempt should be made to differentiate the individual cases into, 1 the relatively slight or mild cases, 2 the serious cases, and 3 the gross cases.

# Corrosive Injuries of the Oesophagus

This is important for *prognosis*, which often is less favourable, and particularly for *treatment*.

Under this heading the history of the development of the methods of treatment is examined more closely.

It emphasizes the importance of beginning treatment before scar formation arises, for which Salzer in particular has made himself the spokesman, since he has recommended that treatment in the form of the daily passage of soft bougies should begin 2 to 6 days after the injury. Others, however, consider that the beginning of the second week is the most favourable time.

Belinoff in particular has maintained that the best treatment of the deeply penetrating necrosis is to use a retained tube, which is accomplished by the help of an external oesophagotomy.

In view of earlier writings and on the basis of the treatment of his own cases, the author recommends that for adults and older children the daily passage of soft bougies after the method of Salzer should be used in the cases of lesser degree. In severe cases external oesophagotomy the introduction of a retained tube is performed.

A retained catheter introduced through the nose is used for small children in the first year of life for the milder cases, and in severer cases external oesophagotomy with a retained tube.

This is illustrated with records of the case histories of patients in the different categories.

Subsequently the treatment, when strictures are already established, is briefly discussed. In individual cases dilatation by diathermy of circumscribed scarring can be readily accomplished. This is illustrated by an example.

Finally the author's own material is summarized. It consists of 52 patients, 34 with the diagnosis of acute corrosive oesophagitis and 18 with the diagnosis of stricture of the oesophagus. External oesophagotomy was performed on 15 occasions. In the follow up of the first group there were 26 cures, 2 much improved and 2 deaths. In the follow up of the second group (strictures), there were 3 apparent cures, 7 much improved, 1 unchanged (died later) and 3 deaths.

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A fuller review of the literature is found in Denker and Kahler's handbook, volume ix.

# A SERIES OF LARYNGEAL INJURIES WITH A DESCRIPTION OF ENDO-LARYNGEAL BURNS

By A. J. MOFFETT (Birmingham)

INTEREST in war injuries is naturally waning. It may not, however, be too late to put on record a series of laryngeal injuries personally observed and illustrated.

## GUN SHOT WOUND OF LARYNX

CASE I.—Male. Age 26. Wounded by what he believes was a Jap machine gun bullet. He was wounded while lying on his face, the enemy fire coming obliquely from the left and in front. He was struck immediately above the right clavicle, and at once blood, which was not frothy, began to pour from his mouth. This soon ceased, but ten days later, he coughed up thick clotted blood mingled with phlegm. Immediately after this, he found that on drinking, some of the fluid came out through the clavicular wound. This persisted for eighteen days, and then ceased. He was first seen by me five weeks after the injury. At that time his voice was hoarse and very weak, and he complained of a pricking feeling, as if he had a fish bone in his throat. The wound above the centre of the clavicle had nearly healed. It appeared to be a wound of entrance, and was partially fixed to the clavicle. A thick fibrous cord beneath the skin ran from this wound to the larynx, marking the track of the bullet. Nothing abnormal could be detected on palpating the larynx. An X-ray revealed no injury to the clavicle, the shadow of the larynx was normal and there was no hold up or irregularity shown on a barium swallow. A radio-opaque foreign body about  $\frac{1}{4}$  inch square was present in the right shoulder region.

The larynx when first seen was considerably inflamed and oedematous, the right vocal cord had completely disappeared and the anterior attachment of the left cord had moved over to the right side of the larynx. The right arytenoid was fixed, but the left cord was freely mobile and came well over to the right side on phonation. Its anterior part was shielded by a sickle shaped fold of mucous membrane, coming from the false cord, which had evidently been injured anteriorly. The immediate surroundings of the larynx appeared normal. The laryngitis subsided rapidly with treatment, but the voice improved slowly. Within six months, it had increased considerably in power and had lost much of its hoarse sound. The right arytenoid moved slightly, and appeared little different from the left. A surviving remnant of the original true cord, or a new one, formed of scar tissue had appeared on the right side. The left cord had increased its excursion sufficiently to touch this during phonation. The appearance on inspiration is illustrated in the sketch made six months after the wounding.

# A. J. Moffett

It is difficult to visualize the track of a bullet, apparently travelling in the opposite direction, which enters the neck at the clavicle, penetrates the pharynx, removes one vocal cord neatly, and finally disappears with scarcely any other damage to the larynx.

## GUN SHOT WOUND OF LARYNX

CASE II.—Male. Age 31. Wounded by a fragment of a Japanese hand grenade, which exploded about twenty yards from him. He was struck just above the inner end of the clavicle on the right hand side. About two minutes after the injury, he lost his voice, being able to speak only in a whisper. This was followed by difficulty in breathing and spitting up blood, which lasted off and on for eight or nine hours. He then became comfortable.

He was first seen by me four days after wounding. A small healthy granulating wound was present above the clavicle on the right side of the neck. X-ray revealed no foreign body. The larynx was a little inflamed. Bruising was present in the right pyriform fossa, on the right ary-epiglottic fold, on the false cord and on the posterior part of the right vocal cord. The mucous membrane everywhere appeared intact and devoid of swelling.

The movements of the left vocal cords were normal. The right cord showed limited movement around the cadaveric position towards both adduction and abduction, but a proper approximation could not be affected, although the left arytenoid overlapped the right during phonation. His voice at this time was little more than a whisper. He was put on absolute silence for a week. At the end of that time, his voice had returned, but was still a little hoarse and some bruising remained. Four days later the voice and larynx were normal.

It is probable that the grenade fragment causing the wound, penetrated the pharynx and was either spat up or swallowed by the patient. The interference with the movement of the vocal cord was probably due to an extravasation of blood and not to a nerve injury.

The illustration shows the appearance when first seen.

## SELF-INFILCTED WOUND

CASE III.—Male. Age 38. While in the delirium of typhus fever, this patient seized a sharp bamboo lath and endeavoured to cut his throat. The result was several jagged wounds in the neck. One large wound had penetrated the crico-thyroid membrane on the left side. A similar wound a little lower had entered the trachea. When first seen, the patient was gravely ill. The wound in the neck was septic and necrosis of the left ala of the thyroid cartilage had begun. An examination of the larynx showed it to be a little injected with poor movement of the left vocal cord. The patient, breathing through his several air ways, had no respiratory obstruction. His condition steadily improved. The anterior three quarters of the left ala of the thyroid, sloughed out and his various wounds healed in about six weeks.

An examination of his larynx at that time showed practically no abnormality during deep inspiration. On phonation, it could be noted that the anterior

# A Series of Laryngeal Injuries

third of the left vocal cord was fixed in abduction. When the arytenoids were approximated, the larynx was never completely closed, a triangular chink being left in the anterior part, with resulting weakness of voice.

This condition is illustrated.

## INTERNAL BURNS OF THE LARYNX

CASE IV.—Male. Age 25. This man was badly burnt by the explosion of a truck load of cordite, on which he happened to be sitting smoking. His two comrades seated beside him were killed instantly. He was admitted with severe burns of the face and hands, and had been treated with saline packs and large doses of sulphapyridine, and sulphathiazole, which had been stopped two days before examination. He was at that time on penicillin.

He was seen by me twelve days after injury. I was asked to see him because during the last three days, he had become cyanotic.

The cyanosis had a mottled appearance, and appeared to be confined to the upper part of his chest and neck. His face and lips were terribly swollen. Several superficial excoriated ulcers were present on the soft palate. The larynx was but little inflamed. A tiny ulcer was present on the edge of the epiglottis, and there were superficial ulcers, similar to those on the palate, on the left arytenoid and false cord. No oedema of the larynx was present. The trachea was uninflamed, and showed no evidence of any membrane likely to cause respiratory obstruction.

This condition is illustrated.

The patient died two days later. The appearance of the larynx and the absence of any obstructing membrane in the larger branches of the bronchial tree was confirmed at post mortem.

I have seen two other cases, so similar as not to merit a separate description. Both recovered.

The examination of these patients is peculiarly difficult. They are seriously ill, and difficult to put in the proper position for the use of the mirror. The face, mouth and limbs are swollen and swathed in bandages, or covered in dyes, while the precincts of the bed is guarded by numerous pieces of apparatus for intravenous and other types of medication. It is probably because of this that the condition is not often seen.

Those interested should consult the account of the Cocoanut Grove Disaster, a synopsis of which is given in *Bulletin of War Medicine*, January, 1944.

CASE V.—Male. Age 28. Wounded in the neck and right arm, by fragments of a Japanese hand grenade, one month before examination. One fragment entered the neck on the right side of the junction of the lower and middle thirds of the posterior border of the sterno-mastoid, and lodged against the seventh cervical vertebra, causing a small fracture of the transverse process. The fragment was removed about six hours after wounding. Following this, the patient developed a right sided pneumothorax, which took about

## A. J. Moffett

two weeks to resolve. Immediately after the wounding, the patient found himself unable to use his voice properly, being able to produce little more than a hoarse whisper. At the time of examination, his voice had recovered considerably, but was very variable in strength and rapidly tired after prolonged conversation. He considered that it was stronger when he had been sleeping on the right side, and weaker when he slept on the left. It had however, shown a gradual increase in strength. At the time of examination, he had a musculo-spinal paralysis on the right side and a small healed wound on the right side of his neck. His voice was weak and hoarse and very variable in strength. The throat and larynx were extremely difficult to examine, heavy cocaineization being necessary before the patient would tolerate a mirror in his mouth. The larynx showed a mild degree of laryngitis, both arytenoids being a little juicy. The right vocal cord was stationary in the cadaveric position, but some movement of the arytenoid could be seen. The left vocal cord moved well, but lacked tension on phonation. Immediately after examination, the patient's voice improved considerably, being much stronger than on any previous occasion. Further examination of this patient could not be carried out, as he was evacuated for treatment of his other injuries. The paralysis of the right vocal cord was no doubt due to an injury to his recurrent laryngeal nerve. The rapid improvement in his voice, following examination suggests that much of his hoarseness and weakness had a functional basis.

This condition is illustrated.



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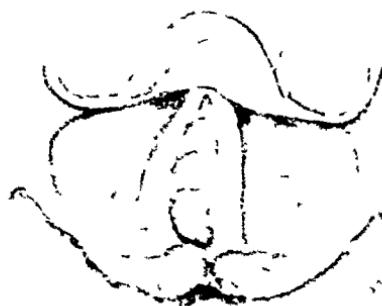
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CASE 1 A remnant or re-constituted portion of the right cord is seen. The anterior attachment of the left cord has been moved to the right

CASE 2 Bruising in the soft tissue and restricted movement of the right cord is shown

CASE 3 This sketch illustrates the triangular chunk present during phonation

CASE 4 The burns on the epiglottis, false cords and arytenoids are shown. The rest of the larynx is comparatively normal

CASE 5 Recurrents paralysis right vocal cord. The lack of tension in the left cord is probably functional

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## SOCIETIES' PROCEEDINGS

### ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

May 4th, 1945

*President—C. GILL-CAREY, F.R.S.C.ED.*

*Clinical Meeting*

**Eleven Cases Presented after Laryngectomy: Ability to Talk.—  
LIONEL COLLEDGE.**

THE PRESIDENT congratulated both Mr. Colledge and those who had taught the patients on the superb result. He could not think of any of his own patients who could compete with those of Mr. Colledge. He would like to ask Mr. Colledge how he set about teaching them and whether they had lessons before the operation, as had been advised in certain quarters.

NORMAN PATTERSON had himself tried and failed to accomplish what Mr. Colledge had succeeded in doing, although he had carried out numbers of laryngectomies.

MUSGRAVE WOODMAN said the mutilating effect of the operation had brought discredit on laryngectomy, but if patients could produce such a voice as did those of Mr. Colledge that feeling should disappear. Many cases of the kind in question went into the hands of radiologists and radium experts, but he thought that the operation should still have its place in surgery. He had treated a fairly large number in his time, and he could not remember anywhere the voice was so good as in Mr. Colledge's cases.

J. C. HOGG said he had learned a great deal from this excellent series of cases. On talking to them he had learned that apparently there was no need for any elaborate or specialized teaching afterwards; in fact, they very kindly told him that the secret of the whole thing was a bottle of soda water and a boiled sweet to suck.

E. COWPER TAMPLIN said that his experience had been that patients treated by radium or deep X-ray were usually fairly miserable. Mr. Colledge's, on the other hand, were a happy, laughing crowd, and that was one very striking difference, of great importance to the patient. Another point, to which Mr. Colledge himself had drawn attention, was that the hemilaryngectomy case did not talk as well as the "total".

LIONEL COLLEDGE, in reply, said the President has asked how the patients were taught. Some taught themselves, some were taught by Mr. MacMahon, and some were taught by the ward sister who had been present that afternoon. The fact that they could talk was nothing new. He saw in 1914 in the clinic of Professor Gluck a man who talked very well, but he was looked on as a *lusus naturae*. All efforts at that time to get patients to talk were devoted

## Societies' Proceedings

rhinoscopy revealed a vascular mulberry-like tumour in the anterior part of the left middle meatus. Histological examination of a portion removed at biopsy was reported as showing "widespread and generalized invasion with well-defined columns of cells some spindle-shaped, with little cytoplasm and hyperchromatic nuclei, with few mitotic figures which are malignant and a few lymphocytes surrounding but not infiltrating the malignant cells".

An external ethmoidectomy was performed on February 12th, 1945. The swelling was found to be firm, projecting through the lamina papyracea and everting the nasal process of the maxilla. It separated readily from adjacent structures but no trace of the lacrimal sac could be identified. The opening into the nasal cavity was enlarged, and a mass of firm but soft polypoid tissue was removed from the ethmoid region. The left middle turbinal was found flattened against the nasal septum. The tumour appeared to originate in the lateral mass of the ethmoid and to displace, without infiltrating, adjacent structures.

Microscopically the growth consisted of groups of closely packed cells with small spherical nuclei and little cytoplasm. The groups are separated by a fibrous stroma. Mitoses are few. In some parts of the section there was definite evidence of infiltration and the growth is histologically malignant.

It was quite definite from the section that the tumour was malignant. It was growing in a manner which suggested that it was rather pushing structures out of the way, and if it was malignant it was only locally malignant. If it was a carcinoma it was surprising, because the patient was only 18½ years of age. It was just three months since the patient was operated on, and they proposed to let him go another three months unless any member had an alternative suggestion to make and a convincing reason for doing otherwise.

LIONEL COLLEDGE thought it might be regarded as a basal-cell carcinoma.

### Extensive Pharyngeal Ulceration.—IAN ROBIN.

W.G., male, aged 24. Extensive pharyngeal ulceration with necrosis of the soft palate and fauces was first noticed over three years ago. Very little change in the clinical condition in the past two years. Chest : X-ray normal. Blood W.R. negative. Three biopsies have all shown "simple granulation tissue only". Swabs have grown on culture *Staph. aureus* (penicillin-sensitive), and non-haemolytic streps. Blood vitamin C content normal. Blood-count shows simple "secondary anaemia" with Hb% varying between 50 and 85. For many years the patient has suffered from severe ulcerative colitis. This has been treated medically, and also by appendicostomy. X-rays of the colon show marked "pipe-stemming". The small firm gland in the right side of the neck has been present for at least seven years. The patient suffers also from infantilism, for which he has received various hormones.

Treatment of the pharyngeal condition has included local and parenteral arsenic; local and parenteral penicillin; large doses of vitamin C; iron; frequent blood transfusions; nearly all of the sulphonamides both locally and by mouth.

The patient is now awaiting admission to hospital for an ileostomy, and subsequent colectomy.

# Royal Society of Medicine

V. E. NEGUS said he had at the present time a case of a similar type under his care, and he had seen one or two in the past. Some had been spoken of as malignant granulomata and others had been given various names. The man he had in mind came from the Army in North Africa, but there had never been an accurate diagnosis. The condition was not syphilitic nor tuberculous nor was it reticulosis. It improved a little with penicillin, which was given both by injection and in pastilles, but it improved only because that got rid of the secondary penicillin-sensitive organisms. It extended over much the same area as Mr. Robin's case. The patient was now having intrabuccal irradiation; the ulceration appeared to be healing rapidly. Although it might theoretically be the wrong treatment for an inflammatory process there did seem to be a good result. Diathermy was not a good form of treatment in this case, though it had been tried.

G. EWART MARTIN said he had seen three almost identical cases. So far they must admit failure in diagnosis of these cases. A tentative diagnosis of reticulosis was made in two cases but he was certain this was incorrect. The third case, a woman of 28, developed a small ulcer on the side of the tongue making swallowing painful. The ulceration continued and eventually the tongue split in two. Serial sections apparently showed simple granulation tissue and every possible blood test had been negative. There was no definite agranulocytosis. The patient became pregnant, the baby was born without any difficulty and was perfectly healthy. The ulceration continued slowly causing a great deal of pain on swallowing. The patient lost and gained weight alternately. Deep X-ray therapy was tried and the upper part of the ulcer healed but it appeared on the posterior pharyngeal wall, passing down as far as the epiglottis. A superficial ulcer appeared on the skin over the thyroid cartilage. Pus from this ulcer showed no definite infection and it eventually healed with deep X-ray therapy. The blood-count has varied. For some time there was a general anaemia and this responded to blood transfusions. Since five blood transfusions were given the ulcer has been partly controlled. The patient was very bright and had put on weight but talking and swallowing were difficult. The diagnosis had failed.

## Carotid Body Tumour.—IAN ROBIN.

W.H., female, aged 22. Noticed three years ago a firm swelling behind the angle of the mandible about the size of a walnut, with the suspicion of an extension upwards and deeply; marked transmission of carotid impulse. Patient found to have paralysis of the left vocal cord, left side of soft palate, left trapezius and sternomastoid muscles, left side of tongue, and left cervical sympathetic. No abnormality in nasopharynx, pharynx or larynx. Blood picture normal.

*Diagnosis of carotid body tumour made. In September 1944 Mr. Hamilton Bailey excised the tumour, after preliminary ligature of the carotid artery. The tumour was well encapsulated, but extended up to the base of the skull, and actually had to be "chipped off" the bone.*

Microscopy confirmed the nature of the tumour.

## Societies' Proceedings

### Bilateral Abductor Palsy following Thyroid Operation Two Years Ago.—N. A. JORY.

L.F., female, aged 56. Two years ago had thyroid operation, after which she had difficulty in breathing. Two months ago attended hospital on account of this. Seen to have bilateral abductor palsy of larynx with stridor and cyanosis. Phonation good. One month ago admitted to hospital, and low tracheotomy performed.

V. E. NEGUS said that Sir StClair Thomson, who had strong views on the subject, advocated permanent tracheostomy. If the patient had a properly constructed tube, of the right shape, and if that tube were properly shaped at the outer end, it was possible to have it made with a valve which gave a wide aperture. The valve did not then project; such tubes were now made and were very convenient because they were out of sight. There was also very little trouble in inserting one in the trachea.

H. V. FORSTER said that he had referred to him a case like the one under discussion. The bilateral abductor palsy had followed an operation on the thyroid gland. He saw the patient from time to time, but remembering the teaching of the late Sir StClair Thomson, would continue to encourage her to wear her tracheotomy tube and not to submit to any kind of intralaryngeal operations.

J. C. HOGG said that he agreed with what speakers had said with regard to permanent tracheotomy tubes. He had a patient who had this disability after a thyroid operation and in due course he had fitted her up with a flap valve which had enabled her to speak but she had refused to go on with it because she could breathe in through it but owing to paralysis of the cords she could not breathe out properly. She decided that it was not good enough and she put a finger on her tracheotomy tube and one would not have known that she had a disability at all.

# The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

December 1945

## CONGENITAL CHOANAL ATRESIA

By A. DURWARD, O. C. LORD and C. J. POLSON (Leeds)

CHOANAL atresia, although rare, is of practical importance because, when bilateral in the newborn, prompt diagnosis and treatment will avert death from asphyxia or inanition. Despite repeated emphasis, first by Ronaldson in 1881, and subsequently by others\*, most recently by Kazanjian (1942), this has yet to be widely appreciated. A clearer and earlier recognition of the cause of nasal obstruction in the first of the present cases might well have saved the patient. The circumstances, however, were unusual in that death resulted from orbital cellulitis and pyæmia; a characteristic, membranous, bilateral atresia was complicated by antral empyema and infection apparently spread to the orbit.

The first case report includes the findings at autopsy, and of microscopical examination of the nasal structures. The second case is a typical example of unilateral, bony atresia in an adult; surgical treatment effected a cure. The opportunity is also taken to review the literature, and prepare a comprehensive bibliography, the survey being restricted exclusively to choanal atresia due to mal-development.

### Bibliography

The first description of choanal atresia is usually ascribed to Otto (1830) who, however, merely stated that "in congenital closure of the hinder opening of the nostrils the palatine bones are very much

\* Payson Clark (1808), Mackenty (1907), Attal (1911), Brady (1918), White (1918), D. B. Kelly (1939).

deformed". This indicates only that the condition was then recognized, but imperfectly understood. It is agreed, with Schroetter (1885), that the reference is worthless. Nor is there any evidence that Roederer (1755) even recognized the condition; a citation of this author by Otto concerns a defect of the temporal bones. Priority properly belongs to Carl Emmert (1853) who cured a boy, aged 7 years, of bilateral bony atresia. The original account is inaccessible but Luschka (1860) related the facts, when reporting the first autopsy examination, on a newborn female with bilateral atresia.

Ronaldson's report of 1881, the first British case, remains a model, notable, in particular, for the steps by which the diagnosis was established. His clinical observations, together with those of Richardson (1913 and 1914), leave little to add to the picture of choanal atresia in the newborn. The first cases of unilateral atresia were described by Mettenheimer (1864) and Gosselin (1876). Choanal atresia was first recognized to be a mal-development by Hopmann (1888) and more recently Stewart (1931) gave a detailed account of its pathogenesis.

The greater part of the literature on this subject is in the form of isolated, or small groups of, case reports, but these provide a clear, if composite, picture. There have been several reviews, commencing with that of Hubbell (1886-87), of 16 cases and one new case. Schwendt's review (1890) is inaccessible, but several of the 25 cases are included by Haag (1899) in his tables. The value of the latter paper is impaired by certain inaccuracies, notably the inclusion, with circumstantial details of choanal atresia, of two cases reported by Jarvis (1887), described in the original report as unequivocal examples of anterior nasal atresia. Recent reviews include those by Cohn (1904), Bilancioni (1916) and Vogel (1925). The largest individual series is that of Kahler (1909), who described nine new cases from Chiari's clinic.

Autopsy and biopsy reports are few, for obvious reasons, and it is to be regretted that on eight occasions\* no autopsy was made. Partial autopsies were described by Ronaldson (1881) and by Moncrieff (1936); three other autopsies are credited respectively to Otto (1841), Kundrat (1880) and Schwendt (1890); two of the subjects were probably foetuses, but the original reports are inaccessible.

Four nasal specimens on record include that of Lack (1901), which is dismissed by the mere statement that it was found in the dissecting room; there is little information about the specimens described by Heymann (1904), and Prentiss (1925). That of Zuckerkandl (1892) is alone of value, and is accompanied by an admirable drawing; it may be, however, that, when fresh, the apertures shown in this macerated specimen were closed by membrane.

\* Lange (1892), Texier (1906), Mackay (1908), de Kleyn (1918), Galand (1924), and three cases in Schreckenbach's series (1937).

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The autopsy reports by Luschka (1860) and Bitot (1876) are impaired by faulty interpretation. Bitot, for example, believed atresia to be produced by an unusual bone, which he named the os triangularis. T. K. Hamilton's first case (1905) is a good report and that of Fraser (1910) is even better, and is illustrated. None of these authors, however, describe the microscopical structure of the obstruction. Comprehensive studies appear to be limited to three, namely, those of Berblinger (1917-18), Altmann (1931), and Schwartz and Isaacs (1942); the latter is especially notable for the excellent photo-micrographs. The first of the present cases is, therefore, only the fourth comprehensive examination to be recorded.

There are a few biopsy reports, the first being by Payson Clark (1898). One by Hochheim (1903), of which White gives a translation, is frequently cited, and another six\*, of which Stewart's is the most notable, have been traced. The rarity of histological details of choanal atresia was noted by Theesssen (1926-27), who found only five instances of 175 case reports; two of these, by Mengel and by Schwendt, are now inaccessible.

It remains to mention certain cases now excluded, but of which some were included by other authors. There is a group of ten cases† of anterior nasal stenosis, a second of six cases‡ of nasopharyngeal atresia, and a third of nine cases§ of membranous choanal atresia, probably due to syphilis.

### The Incidence of Choanal Atresia

The original reports of 262 cases have been examined and verified, and, for statistical purposes, another 30 cases, of which there are adequate abstracts, or citations by two or more independent authors, are also included. Another 98 cases were traced but, although the information left little doubt that they were authentic examples, the details were inadequate for analysis. There was scanty information, insufficient to confirm the diagnosis, of another 34 cases. The present search has thus yielded some 390 authentic cases and, allowing for omissions and doubtful cases, it is unlikely that over 500 have yet been described. The condition is, therefore, rare. Fraser (1910) traced only 115 cases, raised to 150 by White in 1918 and to 180 by Mahoney in 1927. It would seem that Anderson's total of 160 in 1937 was the result of an incomplete search, for the discrepancy between this and the present total is not accounted for by a

\* Charousek (1922-23), Sercer (1923), Magnotti (1930), Stewart (1931), Donnelly (1928) and Otty (1940).

† Jarvis (1887, 2 cases), Downie (1896), Foster (1899), Hovorka (1892), Liebe (1896), Potter (1888-89), Rice (1894), Washburne (1932), and Aquino (1939).

‡ Chiari (1885 and 1900, Case 1), Johnston (1906), Meyersohn (1887), Schlemmer (1912) and Strazza (1892).

§ Aranabia (1934), Baumgarten (1896, Case 3), Briani (1927), Hecht (1902), Scopetta (1908), v Eicken (1911, Case 1), Fumasoli (1934) and Pallestrini (1934, Cases 2 and 3).

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sparse of reports during 1938-44. There were only 41 cases during the latter six years and even the addition of 12 in 1937, including Anderson's six cases, still leaves a considerable discrepancy.

The rarity of choanal atresia is also demonstrated by the fact that those of wide experience have reported but a few cases\*. Were the condition common, it is anticipated that either comprehensive series, at least equal to Kahler's nine cases, would have been described, or the subject would have been ignored. Evidence from clinics of international repute also shows that choanal atresia is rare. Stewart mentioned six cases, all of unilateral atresia, seen amongst 27,863 patients at the Edinburgh Clinic of Logan Turner and Fraser during 1906-26; (only one of these cases has been described in detail, by Fraser). This incidence of 0.02 per cent. coincides with that at the Massachusetts Ear and Eye Infirmary where Kazanjian traced ten cases, three of which he described, amongst a series of 62,228 patients, (0.016 per cent.). The precise incidence at the Mayo Clinic is not stated, but only twelve cases, six described by Anderson and six by Pastore and Williams, were seen during 1907-1939. Kahler collected nine from Chiari's Clinic. Autopsy or museum material includes few specimens of choanal atresia. When Morell Mackenzie examined 2,152 skulls at the Royal College of Surgeons he found four examples of bony synechia, but none of choanal atresia. There was but one, a unilateral atresia, in Zuckerkandl's series of 300 autopsy specimens. The first of our cases is unique in a series of over 5,000 autopsies (5,390) and amongst 326 nasal specimens.

It was suggested by Richardson, Brady and by White that choanal atresia is frequently overlooked in the newborn, dead of asphyxia. Whilst this may happen, the total of unrecognized cases must be small. A study of 1,982 confinements by Lund (1941) showed that severe asphyxia neonatorum, i.e. of the grade likely to result from choanal atresia, was present in only 44 or 2.2 per cent. of the infants, and moderate or mild asphyxia was present in only another 12.8 per cent. It was further demonstrated that 70 per cent. of all asphyxia neonatorum was a result of prematurity, especially when labour was conducted under the influence of analgesic drugs. Choanal atresia is not even mentioned as one of the several factors discussed and, presumably, no instance occurred in this series of confinements.

## The Classification of Choanal Atresia

The early classification by Baumgarten (1896), of true and false varieties of choanal atresia is rejected because, in the majority, atresia is a mal-development, and this mode of classification, has no practical

\* Voltolini, Solis-Cohen, Onodi, Payson Clark, Creswell Baber, StClair Thomson, and Dan Mackenzie.

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value. Grouping based upon the composition of the membrane, favoured, in particular, by Richardson (1914), is also rejected because this bears only upon treatment ; also it is frequently impossible to determine the precise aetiology of membranous atresia, especially in adults, and it is by no means certain that "bony" atresias are always wholly composed of bone. The classification by Kayser (1900) approved by Chiari, Boulay, Uffenorde, Attal and others, is based on the site of the partition ; he recognized "intranasal", "marginal" and "retronal" types. The present view is that retronal or nasopharyngeal atresia, exemplified by Chiari's first case in 1909, is a separate entity, outside the scope of this review ; on the other hand, no real distinction exists between the "intranasal" and "marginal" types. According to the records, and as in our first case, intranasal atresia is by partitions inserted 2-3 mm. anterior to the choana, whereas in the marginal type, they lie at the orifice, a difference which is scarcely other than fortuitous. If, as claimed by Mouret and Cazejust (1921), the choana be a canal rather than an orifice, there is still less justification for maintaining a distinction between intranasal and marginal atresias. Classification on the basis of the degree or grade of obstruction, as by Bilancioni (1916), and Mouret and Cazejust, is the most practical, in that the clinical features are thus determined, rather than by the site, or composition, of the partition.

Three groups are here recognized, namely, (*a*) bilateral, with a subgroup of incomplete bilateral atresia, (*b*) unilateral atresia, and (*c*) choanal folds ; incomplete unilateral atresia is classed as a choanal fold.

Estimates of the incidence of the grade of atresia differ, but unilateral atresia, especially of the right choana, is the common type. Boulay (1902) reviewed 65 cases and found that 39 (60 per cent.) had unilateral and 25 had bilateral atresia ; the right side was involved in 29 (74 per cent.) of 39 patients. Fraser (1910) found that 58, or 54 per cent., were unilateral, 40 bilateral and the grade was not stated in another 10 patients ; the right side was involved in 36 or 62 per cent. of 58 patients. In a series of 153 cases collected by Balla (1907), 72 were bilateral, and 70, or 45 per cent. unilateral, with right atresia in 47 or 67 per cent. ; the grade was not stated in the other 11 patients. Stewart gave no data, but regarded unilateral atresia as the commoner, whereas Richardson believed that bilateral was thrice as common as unilateral atresia. The present 292 cases included 185 or 63 per cent. unilateral, 89 bilateral, 14 incomplete bilateral atresias and 4 choanal folds ; the right side was closed in at least 112 or 61 per cent. of 185 cases of unilateral atresia.

The precise incidence of choanal folds cannot be ascertained because this grade of obstruction, due to a fold in the upper part of the choana, is likely to be without symptoms, and may thus escape detection. According to Porter (1907), these folds were present in one of every three

persons he examined, and he found choanal folds in 17 of 41 anatomical specimens. Payson Clark (1908) described two cases of bilateral folds and the only other author to comment on these folds was Hopmann (1895), who said they were rare.

Present experience supports Hopmann's view, and the high incidence recorded by Porter is not confirmed. A detailed examination of 326 specimens, prepared by the method previously described (Polson, 1942B), yielded but one example (P.M.4887) of choanal folds present as narrow strips, limited to the choanal roof, as in Porter's third type.

### Pathogenesis and Embryology

The development of the posterior nares is consequent upon a series of changes occurring in the primitive mouth and nasal cavities. With the

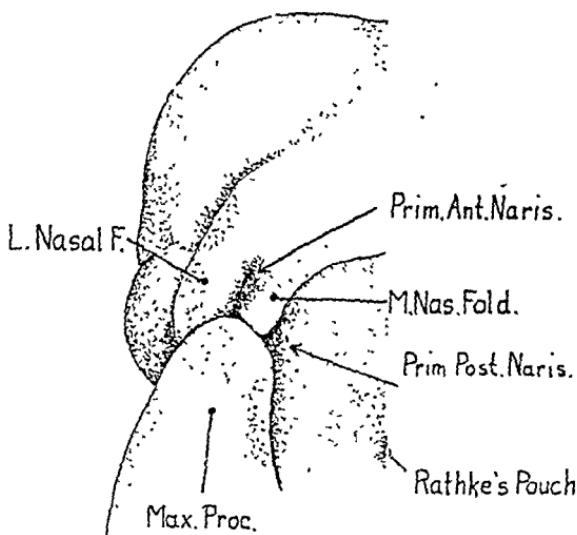


FIG. I.

Mouth from below. L. Nasal F.—lateral nasal fold. M. Nas. Fold—medial nasal fold. Prim. Ant. Naris.—primitive anterior naris. Prim. Post. Naris—primitive posterior naris. Max. proc.—maxillary process. (after Frazer).

formation of the olfactory pits, as depressions from the surface extending over the primitive mouth, a partition comes into existence between oral and nasal cavities. Between the two primitive nasal fossae a median partition is left to form the basis of the nasal septum. When the nasal pits are small they are excluded from continuity with the mouth by a bucco-nasal membrane; this membrane is nothing more than the apposed epithelial coverings on the maxillary process, the median nasal and the lateral nasal folds (fig. 1). As extension of the nasal fossae

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takes place and with growth of all the adjacent structures this bucco-nasal membrane becomes stretched and breaks through so that continuity is established between the buccal and nasal cavities. This orifice is at first placed well forward on the roof of the mouth, but it extends backwards so that in due course two longitudinally disposed deficiencies may be seen on the roof of the mouth separated by a median

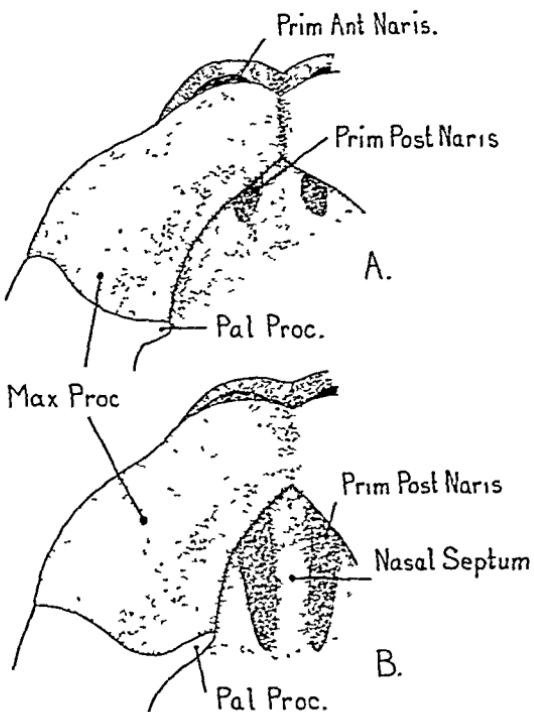


FIG. 2

A and B Views of roof of mouth from below at successive stages in development of palate and posterior nares Max proc—maxillary process Pal proc—palatal process Prim ant naris—primitive anterior nares Prim post naris—primitive posterior nares (after Frazer)

mass which is the lower border of the nasal septum. These elongated deficiencies (fig. 2) are the primitive posterior nares and they clearly delimit the nasal regions above from the oral and pharyngeal regions below.

Secondarily the palatal folds grow inwards from the maxillary processes and meet each other in the midline and also fuse with the lower border of the nasal septum. This fusion with the nasal septum is not however co-extensive with the whole antero-posterior extent of the primitive posterior nares; the palatal folds encroach upon and cover only the anterior parts of the primitive posterior nares; the posterior

ends of the latter remain open as the definitive posterior nares. The posterior parts of the palatal processes, fusing with each other but not with the nasal septum, form the basis of the soft palate. Thus the definitive posterior naris is not a new feature—it is a persistence of the posterior portion of the primitive posterior naris.

To explain atresia developmentally there are several possibilities. The first is that the posterior extent of the primitive naris may have been inadequate and when the palatal folds approached the midline they would fuse with the whole extent of the exposed lower border of the septum. Thus the nasal fossa would have no outlet at its pharyngeal end and the remaining tissues might subsequently persist as a thick or thin membrane or might break through in a variety of ways. Such a theory allows of the explanation of the variety of membranes which may be found and also of their variation in position. Secondary ossification within the closing membrane might well occur.

Another possibility might be the formation of a normal primitive posterior naris with a subsequent complete fusion of the palatal folds with the whole extent of the exposed lower border of the septum. This however is not favourably viewed since a soft palate is present in cases of atresia, indicating a normal disposition of the posterior ends of the palatal folds. Further the septum which occludes the posterior naris in cases of atresia is not shown to contain muscle as might well be expected were it formed by abnormal disposition of tissues intended for the soft palate.

The view then is favoured that the congenital atresia most likely results from a failure in full development of the primitive posterior naris—a failure at the posterior end. This is consistent with full palatal development and with the variations in structure and disposition of the membrane found to occupy the position of the posterior nares.

#### The Morbid Anatomy of Choanal Atresia

In complete atresia, whether unilateral or bilateral, obstruction is by a partition, situated at the choana; it is attached, above, to the basisphenoid, to the wings of the sphenoid, on the outer side, and to the vomer on the inner side; below, the attachment to the bony palate is a little variable, in that it may be at the choanal margin or, as is not infrequent, at a point 1 to 3 mm. in front of the posterior end of the vomer. The partition, therefore, tends to be inclined forwards and downwards. It may be flat or slightly curved, when the convexity is usually described as forward. The partition is approximately twice as high as it is broad, yielding, as in our first case, a choanal index of 50, or as in that of T. K. Hamilton, one of 53.

Each face of the partition is covered by mucous membrane, derived from the adjacent mucosa. Anteriorly, this is indistinguishable from

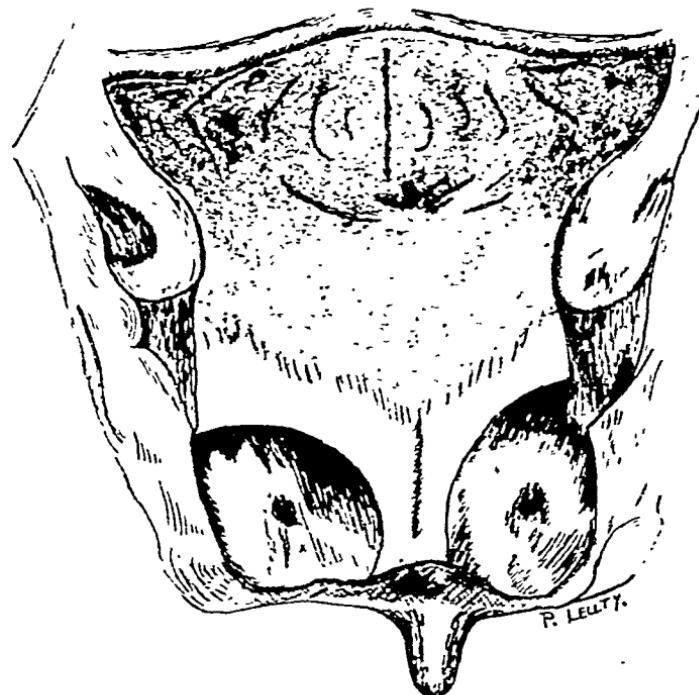


FIG. 3.

Choanal atresia; posterior view of the choanal partitions, showing, especially, the central dimple.



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that of the nasal fossa, whereas, posteriorly, it resembles that of the nasopharynx. In life, the anterior face of the partition is rather paler than the surrounding tissues, and is described as having a pale rose-yellow, or grey-yellow tint (Krieg : Boulay : Fraser : Brunk) ; in our autopsy specimen it had a greyish colour. Anteriorly, the partition is smooth, but posteriorly, well illustrated by our specimen (fig. 3, and those of Anton (1890) and Kahler (1909)), a small depression at or about the centre of the partition is commonly seen. This has been described as a minute indentation, depression, pit or dimple (Grübchen) whilst in a few patients it was a blind canal or even a minute perforation. These dimples measure approximately 1 mm. in diameter, and are about 0.5 mm. deep. Microscopy, as in Schwartz and Isaacs' (1942) case, but not in ours, may demonstrate a minute perforation at the apex of the dimple. Although most are probably blind pits, in all specimens it is likely, as in that of Schwartz and Isaacs, and Berblinger, bone is absent in this area. In a few cases, as in those of Fraser and Morton, the defect is eccentric and is situated on the septal side of the partition. These depressions, or perforations, were found in at least forty patients\* and it is likely that this feature is common, if not constant, in bilateral atresia ; posterior rhinoscopy was sometimes omitted. This belief is strengthened by the fact that a central depression was found in six, and a small central perforation in another of Kahler's nine cases. Dimples in unilateral atresia are rarely described ; Kahler's ninth case, which is illustrated, is an example.

Microscopy confirms that the mucosa over the partitions resembles that of the adjacent structures. There may be a little lymphoid tissue, and some mucous secreting glands in the sub-mucosa (figs. 4 and 5). Inflammation is absent or negligible and at no time is there fibrous repair as in syphilitic membranes. Although the partition in our first case was wholly membranous, there is no trace of any inflammatory reaction in it. Membranous atresia in the adult, or juvenile, may present some difficulty in precise diagnosis. It is clear that a mild inflammatory reaction in the mucosa, is almost constant in nasal specimens from town dwellers, and this may raise doubts about the otherwise congenital ætiology of atresia in these patients.

These partitions range in thickness from 1 mm. to 10 mm.† and it was sometimes found that the central area is only about half the thickness

\* Baber, Kelly D. B., Barwell, Bentzen, Berblinger, Brose, [Brunk (2 cases). Charousek, Citelli, Claoué, Cohn, Eulenstein, Feuchtinger, Jaques, Juffinger, Lange (3 cases), Marschik, Nager, Pfingst, Piffl, Porter, Ridout, Schwartz and Isaacs, Stewart, Wright, Zanni (2 cases) and the present case 1 ; also Fein, Hems and Heys (cited Berblinger, and Hochheim (cited Brunk).

† 2-9 mm. (Clark) ; 3 mm. (MacKenty) ; 3-4 mm. (Attal) ; 4 mm. (Martini ; Roth) ; 6-10 mm. (Schwartz and Isaacs) ; 7-8 mm. (Eulenstein) ; 1/16 in. (Pfingst) ; 1/12 in. (Baber).

of the peripheral portion, e.g. in Knight's patient the estimated thickness was  $\frac{1}{8}$  inch at the centre and  $\frac{1}{4}$  inch at the periphery. The membranous partition in our first case, except at the dimples, had a uniform thickness of approximately 1 mm. Most are composed, or almost wholly composed, of bone. Since this is usually determined by clinical methods alone, it is not known whether those described as "bony" were always wholly of bone, which can only be precisely determined by microscopy. Lebensohn estimated that 90 per cent. of the partitions were bony. In Fraser's series, 89 were bony, 10 were membranous and the composition of the

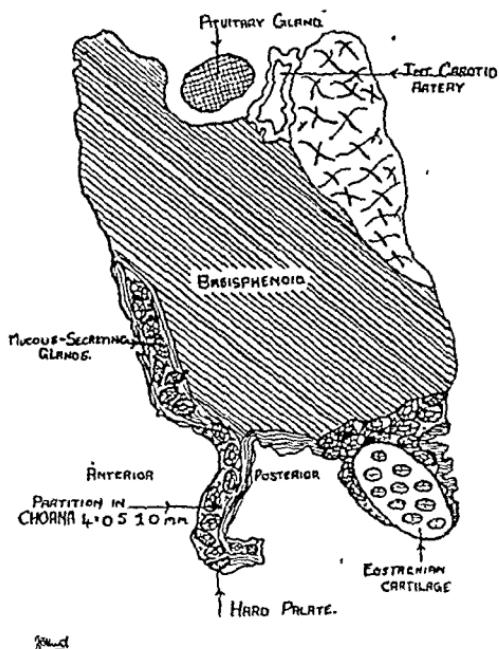


FIG. 4.

Choanal atresia; low power (x      ) of the partition and adjacent structures.

other 9 was not stated. Boulai found 51 of 65 partitions to be bony. The present series of 292 cases confirm the high incidence of bony partitions, for they totalled 196 or 67 per cent. A mixed composition, nearly always osseo-membranous, was found in another 39 or 13.4 per cent. whereas only 29, or 10 per cent. were membranous; the composition of the remaining 28 was either unstated, or not determined. The bone is histologically indistinguishable from that of normal nasal structures. Hochheim likened it to that of the hard palate, and Charousek described the partition as composed of two plates of compact bone enclosing spongiosa. The first illustration by Clark (1898) is crude but those of Schwartz and Isaacs, and of Berblinger are of exceptional quality.

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One unusual "bony" partition, apparently unique, contained only calcareous material (Donnelly). Although partitions of mixed structure are usually composed of bone and fibrous membrane, there are a few instances of the presence of cartilage, as proved by Stewart and by Schwartz and Isaacs. This appears first to have been noted by Ónodi, but his original account is inaccessible, and it is not known whether there was microscopical proof. Richter also found cartilage in a partition, but no microscopical details are given in the report. It is believed that were these

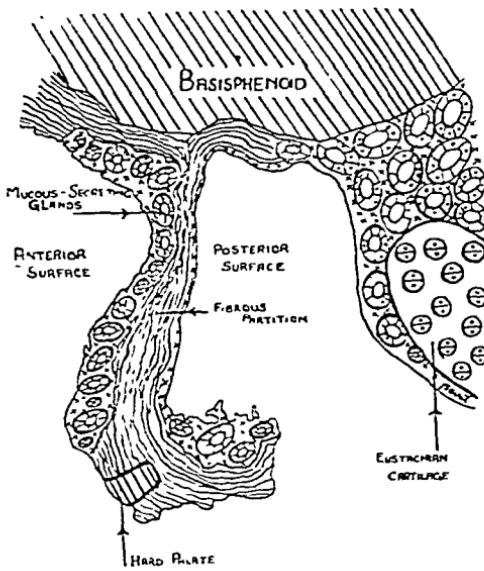


FIG. 5.

Choanal atresia ; (x ) showing the structure of the partition.

partitions more often subjected to microscopy, a mixed structure, especially the absence of bone at the centre, would prove the common finding. Clinical examination alone cannot always distinguish beyond doubt between an area of thin bone and one of membrane in these partitions.

Choanal atresia, as already stated, is commonly unilateral, accounting for about 60 per cent. of cases and with closure on the right side also in about 60 per cent. of unilateral atresia. Incomplete bilateral atresia is unusual and was found in only 14 patients, in three of whom obstruction was by bilateral folds (Clark : two cases : Porter). Incomplete unilateral atresia was found in only six of 390 patients, three on the left side (Ónodi : Morton : Turtur) and three on the right (Kahler : Schwartz and Isaacs, and Stinson) ; these include not only major folds, but also septa in which a minute perforation was alone found. Another unusual

variant of choanal atresia, present in only four patients, was complete unilateral atresia, accompanied by incomplete atresia on the opposite side (Beausoleil : Bellin and Leroux ; Grannone : Citelli). Apart from septa bearing minute perforations, incomplete atresia, as described by Porter, may range from folds, which pass from the septum to the choanal roof with attachment on the outer wall down to the level of the posterior end of the turbinate body, to remnants which are but a narrow strip of tissue in the choanal roof ; even the latter folds, as shown by Porter, may contain bone.

## Clinical Features of Choanal Atresia

### i. Age Incidence.

This mal-development is to be expected to come under observation at an early age because, apart from the serious effects of bilateral atresia, few patients will indefinitely tolerate the discomfort, or disability, due to unilateral atresia. Balla found that of 115 patients of known age, 78 were under 21 and 93 were under 41 years ; the majority, 57 patients, being from 11-20 years of age. (These figures make no distinction between bilateral and unilateral atresia.) This is confirmed by the present analysis of 290 cases. Of these patients, 198 or 68 per cent. were under 21 and 242 or 84 per cent. were under 31 years of age at the date of diagnosis. In view of the milder effects of unilateral atresia, its recognition may be delayed beyond that of bilateral atresia, but the evidence shows that in the majority of cases there is no undue delay. The unilateral group of 185 patients included 132 or 71 per cent. who were less than 21 years, whereas the corresponding incidence for bilateral atresia was only slightly greater, namely 66 of 87 or 76 per cent. of patients.

The decadal incidence of Balla's series was ; 1st decade : 21 ; 2nd decade : 57, or 43 per cent. ; 3rd decade : 25 ; over 41 : 12 patients ; the age of another 38 was not stated. It is now confirmed that the maximum incidence, one of 47 per cent, is in the second decade. The present decadal incidence is : 1st decade : 61 (26 unilateral : 35 bilateral) ; 2nd decade : 138 (106 : 32) ; 3rd decade : 47 (32 : 15) ; 4th decade : 19 (14 : 5) ; 5th decade : 12 (10 : 2) ; and 6th decade : 5 (4 : 1) ; the age of 10 patients was not stated. There were 31 patients of under a year old and of these 5 had unilateral, and 26 had bilateral atresia.

It has been held from time to time that bilateral choanal atresia is incompatible with life. Mouret and Cazejust, for example, accepted only four as authentic survivals, and rejected all the others on the ground that the patients had had incomplete bilateral atresia. This rejection is invalid, because patency in incomplete bilateral atresia was usually slight (e.g. Schwartz and Isaacs : Casselberry), and, in consequence, its clinical

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effects differed in no material fashion from those of complete atresia. The question of survival is best assessed when bony atresia is alone considered; patients with membranous atresia may have acquired the obstruction during adult life. There were 46 instances of unequivocal bony bilateral atresia in the present series. These included 11 patients aged 21-45, and another 17 aged 11-20 years. Not only does this demonstrate that there may be survival in spite of untreated bilateral atresia, but that amongst choanal atresia it is not rare. The group of 11 patients, aged 21-45, represents an incidence of 2.8 per cent. in the present series of 388 unequivocal cases. None the less, a sanguine attitude towards bilateral atresia is not permissible, for, unless promptly recognized in the newborn, and adequately treated, although the infant may not die, there is a distinct risk that complications, notably infection of the antra, and perhaps the orbit, may ensue; a stormy infancy, characterized by difficulty in breathing and suckling is almost inevitable.

Knight was impressed by his patient's long tolerance of choanal atresia. The present analysis shows that 34 patients did not come under observation until they were over 30 years of age, but, as might be expected, only 7 of them had bilateral *bony* atresia. The oldest patient, a man of 56 (Escat) was one of 3 microcephalics with bilateral atresia. It is likely, as was found amongst patients with rhinoliths, that undue tolerance of these troubles is by persons of low grade mentality (Polson, 1943a).

Membranous bilateral atresia, whether complete or incomplete, was usually found in older patients, and in them atresia may have been acquired during adult life. There are a few instances, for example the first of our cases, of true congenital membranous atresia.

Intranasal changes associated with choanal atresia are uncommon and variable. Lebensohn and Briani, for example, spoke of atrophy of the inferior turbinate body on the atresic side but, in other patients (Bleyl, Joel Scheier, and Stewart) there was hyperplasia, with or without polypoid swelling of its mucosa. In most reports, no mention is made of the turbinate body, presumably because it was healthy.

The co-existence of other congenital malformations with choanal atresia is no more than fortuitous. The few instances include a bifid uvula in Lebensohn's patient, a bilateral double tragus in that of Binnert, and a slightly bifid nose in that of Kazanjian. Unequal alae nasi and a nasal fistula were present in another (Vogel), and yet another had a coloboma of the iris (Thomasson).

Several authors have endeavoured to demonstrate that choanal atresia, when unilateral, leads to asymmetry of the face or the palate. There are patients, however, for example, those of Baber and Hanzel, in whom facial asymmetry was noted on the side opposite to the atresic nose. It is pointless to reopen the subject since, as H. G. Wells observed

in his Plattner story, some facial asymmetry is to be found in the majority of people. Potter showed that nasal atresia and facial asymmetry co-existed in only 12 per cent. of patients, and his remarks upon this apparent association should have been sufficient once and for all to demonstrate its fallacy.

## 2. Sex Incidence.

Although Stewart found males and females in equal proportions, the general experience suggests that choanal atresia is commoner in females. There were 71 females and 47 males in Balla's series of 118 patients. The present series of 292 patients included 187 or 65 per cent. of females, and 90 or 30 per cent. of males ; the sex of only 15, or 5 per cent., including 10 children, was not stated.

## 3. Symptoms. (i) *Bilateral choanal atresia.*

It is to be expected, as appreciated by Knight in 1889, that bilateral atresia will usually cause serious effects. This is confirmed by the case reports, and patients, in whom bilateral atresia is a chance finding, are indeed exceptional. Hart (1926) described a woman of 21, in whom nasal atresia was found during a routine clinical examination. She had sought advice for eye trouble, and, except that she had the facies of a mouth breather, she had no nasal symptoms.

The newborn infant has to acquire the mechanism of mouth breathing and, therefore, bilateral choanal atresia may cause urgent symptoms and result in death from asphyxia. The case records demonstrate that there are two principal groups, namely, patients with cyclical asphyxia, the symptoms of which are especially urgent, and those who have asphyxia during suckling. Although the latter are in less immediate danger, failure promptly to recognize and treat the cause may result in their death from starvation.

There is little to add to the excellent reports by Ronaldson and Richardson of patients with cyclical asphyxia. This feature was first emphasized by Richardson and confirmed, amongst others, by Moncrieff and by Colver. A cinématograph record of an attack was prepared by van Gilse.

Ronaldson described a female infant, born at full term, whose respiratory obstruction was apparent at birth. The cheeks and lower lip were indrawn and these were symptoms of asphyxia, promptly relieved when the child opened its mouth to cry. Steps were then taken to keep its mouth open and the tongue drawn forwards. While an airway was maintained, respiration was free and the child breathed strongly and had a lusty cry. Ronaldson appreciated that the obstruction was, therefore, in the nose. He found, what is now a well-recognized feature, much translucent mucus of "glue-like" consistency

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in the nasal fossae, and noted that its removal failed to establish an airway. He then attempted to blow air through the nose and this test, confirmed by probe examination, demonstrated an obstruction at the back of the nose. It was believed safe to defer treatment until the following day, but the infant died of asphyxia during the night. After death, digital examination confirmed that the posterior nares were obstructed by a firm membrane. Richardson's report was similar, but he described more fully the recurring phases of the asphyxia. A quiescent period is followed by one of asphyxia, promptly relieved by opening the mouth, but the cycle is repeated when the mouth closes.

In the second group of patients, asphyxia at birth may be negligible, but is apparent as soon as the child attempts to suckle. They may snore or breathe heavily during sleep, but urgent symptoms ensue only when mouth and nose are closed during suckling. These patients, if untreated, may survive a few weeks or months, but if untreated will then die from starvation. The records of patients who have survived tell of a stormy infancy, characterized by difficulty in suckling and, in some cases, also by frequent attacks of suffocation during sleep. This was well illustrated by Emmert's patient, who did not come under observation until 7 years of age (Luschka). The mother of another patient, a girl of 18, recalled difficulties experienced during infancy (Brady). Although these patients cause less anxiety than those with cyclical asphyxia, deterioration may be rapid and call for urgent treatment, as illustrated by one of Texier's reports; for some obscure reason, there was no autopsy, prompt perforation of the choanae failed to relieve the patient, who died, when aged two months, of broncho-pneumonia. Mackay's patient had no asphyxia at birth and cried heartily. Respiratory distress was apparent only as noisy breathing when the lips were closed; the child was unable to suckle. Artificial feeding was promptly begun, but the infant died a month later owing to the intercurrence of vomiting and diarrhoea. Galand also lost a patient in similar circumstances, in spite of an otherwise successful cure of choanal atresia. Stinson was more fortunate. His patient had no urgent asphyxia but she breathed heavily during sleep and was unable to suckle. Perforation of the choana not only gave prompt relief but effected a complete cure, there being no recurrence at the end of four years. Our first case is another example in this group. She was not asphyxiated at birth, but respiratory difficulty was promptly exaggerated when the infant attempted to suckle. Treatment by artificial feeding was vitiated by the complication of nasal sinus infection, and later, by orbital cellulitis, terminated by death from pyæmia.

It is exceptional for patients to belong to neither of these two groups. Wright described sisters, aged respectively 14 and 15 years who had neither asphyxia at birth nor any apparent difficulty in suckling. At

all times, however, their breathing was noisy and led their father to call them "his two little steam engines". Each had twice been submitted to removal of the adenoid, without relief of their symptoms. The patients who survive to adolescence or adult life, without treatment, usually present with symptoms and signs which simulate those of nasal obstruction by an adenoid, although obstruction by choanal atresia is the more complete (Boulay : Wright). The patients are mouth breathers and have a "nasal" voice; they may have the "adenoid facies". Loss of smell, even to anosmia, is usual, and there may be impairment of taste. Obstruction of the nasal fossae by tough, glairy secretion is a characteristic and almost constant feature, exceptions being those patients in whom this secretion has become infected and is muco-purulent or purulent. Mouth breathing may give rise to the complaint of dryness of the mouth and throat. Patients may occasionally complain of conjunctivitis and this, as in Hart's case, may be the principal disability. Impairment of hearing is unusual, for the majority of reports describe it as unimpaired or good.

(ii) *Unilateral Choanal Atresia.*

Unilateral atresia in the infant may, at times, simulate the bilateral type, especially if nursed at the breast with the patent side against the mother. It is likely, also, that nasal obstruction in these infants may become almost complete if they catch cold. There may be difficulty in suckling, but no instance of cyclical asphyxia is traced. Most of the patients, however, were without symptoms until of an age to appreciate the discomfort occasioned by unilateral atresia. Even then, several regarded this as no more than a nuisance. Most came under observation after, rather than before, 10 years of age, but the majority sought advice by the time they were 30. Whilst some had not perceived the existence of nasal obstruction, it was more usual for the patient to say that unilateral obstruction had existed for as long as they could remember. Excessive nasal discharge was the next most prominent symptom. In some patients, for example those of Tawse, Lumsden Cook and of White, this was distressing, and, indeed, incapacitating, for they were compelled constantly to hold a handkerchief to the nose. Other patients, for example those of Morgenstein and Bonham, were troubled by profuse nasal discharge whenever they bent forwards. Excoriation of the lip by the constant passage of nasal secretion was also reported (Kelly, D. B. : Roth). Inability to clear the nose by blowing was a common symptom, as was also snoring during sleep. Some patients complained of unilateral loss of smell. Zaufal was the first to notice excessive sweating of the face on the occluded side, since described by Lang, Morf, Centario and Tato, and, with good illustrations, by Vogel.

The signs of choanal atresia are adequately to be inferred by reference

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to the account of the morbid anatomy and diagnosis. No useful purpose is, therefore, served by their repetition in this section.

## Complications

The complications of choanal atresia are few and uncommon; they arise from infection of the retained nasal secretion. Although suppurative rhinitis is believed not to occur in an open nasal fossa, it is predisposed to by nasal obstruction. This was regarded as a prime factor in the pathogenesis of rhinitis caseosa (Polson 1942a), and nasal obstruction by a rhinolith was not infrequently complicated by suppuration (Polson, 1943a).

Nasal suppuration as a complication of nasal atresia is recorded by some thirty authors\*, who described it either in terms of muco-pus or purulent nasal discharge or under the diagnosis of suppurative rhinitis. On the other hand many patients had escaped nasal infection over long periods, their nasal discharge remaining mucoid, up to the time when they were first examined.

Antral infection, next in frequency as a complication, was recorded by less than twenty authors† and in two instances (Briani: Donnelly) the evidence was that of radiology alone. There is now no confirmation of the belief of Hart and Peeler that sinusitis is an inevitable complication of bilateral atresia in infants. Dean's statement that he found sinusitis in all the children he had seen with atresia is of little value, since he furnished no details. Moreover, it is not impossible, indeed it is likely, that antral changes in adults, who also have atresia, may be intercurrent. Routine inspection of the nasal structures at post-mortem has already shown that antral disease, as found by Schwartz and Isaacs in their patient, is relatively common in unselected subjects. Antral disease was present in 31, including 10 with empyema, of 140 consecutive nasal specimens (Polson, 1943b); the incidence is similar in the subsequent series, which now totals 303 specimens, for these include 65 cases, of which 19 had empyema, of antral disease.

Infection of the other sinuses is distinctly rare, only two examples having been traced. Winslow's patient had suppuration both in the sphenoid and ethmoid sinuses, and Childrey found pus in the ethmoid cells of his patient. No record has been found of an instance of frontal sinusitis as a complication of choanal atresia.

\* Nasal suppuration was present in the cases of:—Aboulker, Berblinger, Briani, Brose, Eulensteine, Fallas, Flatau, Hamilton (T.K.), Jaques, Kazanjian, de Klein, Koch, Krieg, Lumsden Cook, Magnotti, Martini, Phleps, Reverchon and Didier, Roth, J. H., Sattler, Thrasher, Waldow, and in our first case.

† Antral sinusitis was present in the cases of:—Anderson, Barraud, Boulai, Briani, Brose, Donnelly, Hart, Hecht, Koch, Lumsden Cook, Martini, O'Malley, Roth, Schwartz and Isaacs, Zanni, and in our first case. Childrey found pus in the ethmoid cells of his patient.

Extension of nasal infection to the orbit is well recognized, and is illustrated by a series of six children, all under 14, described by Lumsden. It is believed that orbital cellulitis in our first case was an extension of nasal infection.

There is only one example of "rhinitis caseosa" associated with choanal atresia. Casselberry described an adult male who had almost complete left and partial right choanal atresia, discovered only after the nasal fossae had been cleared of viscous, foul smelling pus. Referring to the patient on a later occasion, in 1913, he described this as "cheesy masses" and made a diagnosis of ozæna. Rhinitis caseosa is unlikely in these patients because, although there is nasal obstruction, deemed an important causal factor (Polson 1942a), complete obstruction excludes drying air-currents, which are also important in the development of this condition.

Otitis media sometimes accompanies choanal atresia, but, in the majority of patients, hearing is unimpaired. When it does occur, it may be on the atresic side, but patients have been described, for example by Patterson, Beynes and Fraser, in whom otitis was on the opposite side; this was also noted in two of the six patients in the Edinburgh series (Stewart). It is therefore concluded that otitis media, which is a common disease, is an intercurrent event, and not a specific complication of choanal atresia.

The co-existence of foreign bodies or rhinoliths with choanal atresia has been described. One of the six Edinburgh patients had a cherry stone in the atresic nasal fossa (Stewart) and Bleyle removed a laminaria bougie from one of his patients. According to Hérriset, Chiari found a rhinolith in an atresic nasal fossa, and more recently Vulowitsch recovered a rhinolith, the nucleus of which was a piece of flint, from a right nasal fossa, and then demonstrated atresia of its choana.

The death from meningitis and cavernous sinus thrombosis described by Lange, is attributable rather to the operative procedure than to choanal atresia.

#### Diagnosis

The diagnosis of choanal atresia, as judged by some of the case reports, might seem difficult because not a few patients have been subjected to one or more nasal operations before the real trouble was discovered. Cavenhaugh, for example, described a child of 12 who was thrice operated upon, for the removal of an adenoid, and resection of the inferior and middle turbinate bodies. On the last occasion failure of "through and through" irrigation led to the diagnosis of choanal atresia, but by this time it is scarcely surprising that the parents refused to allow further surgical treatment. Another patient, a woman of 35 years, had undergone three operations for the removal of nasal polypi before choanal atresia was discovered. It is of interest to note that the

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mother recalled that, when a child, her daughter had been a "greedy" baby, and had had difficulty in suckling (Asherson). These two cases are exceptional. There is little doubt, as judged by the majority of reports, that the real difficulty in diagnosis, as maintained by Boulay, is forgetfulness or ignorance of the condition. Ronaldson showed that the intelligent application of simple tests will lead to the diagnosis, even if the condition be unfamiliar.

If an infant, observation of the patient in its cot is of first importance, and will readily detect cyclical asphyxia. A careful history, and observation of the child during suckling will detect the second group of patients. Confirmation of the diagnosis is most readily obtained by probe examination, especially if a curved probe be used. In addition to resistance offered by the partition, there is failure to pass the probe behind the soft palate into the oral pharynx. It is superfluous to attempt injection or insufflation tests. Several authors (Gosselin, Sommer, Brose and Walliczek) injected water, and others (Colver, Lebensohn, Mahoney) used a weak solution of methylene blue to demonstrate obstruction. These injections are not without risk for, in a patent nose, the fluid may enter and infect the middle ear, or it may enter the air passages. Insufflation of air (Ronaldson, Colver, Daubret) is a safer procedure, and Politzer's method may be used (van den Wildenburg). Examination of infants by anterior or posterior rhinoscopy is unlikely to aid in the diagnosis of choanal atresia, nor has digital examination value, when compared with the curved probe.

Adults with bilateral atresia may superficially resemble patients with an adenoid, for both groups are mouth breathers, and may have the "adenoid" facies. Obstruction in choanal atresia, however, is usually absolute (Boulay and Wright). Anterior rhinoscopy will demonstrate an accumulation of viscid mucus in the nasal fossae, an almost constant feature; only occasionally have the partitions been seen by this route (Krieg, Paterson, Fraser and others). If constricting agents be used, and this does not appear a common practice, anterior rhinoscopy is to be expected to demonstrate the obstruction in most patients. It should also be noted whether there is any movement of the nasopharyngeal wall when the patient swallows; this will be absent in an atresic nasal fossa. Gross septal deflection, large nasal crests or nasal polypi may well obscure the view, but here again the use of the curved probe should rarely fail to detect atresia.

Posterior rhinoscopy furnishes the best information, not only of the kind of obstruction, but also of its extent. It may be the only means of distinguishing between choanal atresia and a large foreign body; the diagnosis was thus promptly established in de la Mothe's remarkable case (1924). Digital examination is of less value, but Stewart mentioned that choanal atresia was found in each of six cases by this method.

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Boulay also stressed its value, but few will agree with Knight, who preferred it to the mirror.

Unilateral atresia in infants is not unlikely to simulate a bilateral obstruction, on account of difficulty in suckling, if the child be habitually nursed with the open nose against the breast. Richter describes a simple test, which involves no more than separate closure of each nostril by pressure on the ala nasi. Respiratory distress results when the open side is thus closed. Probe examination in the infant and adult is invaluable. Not only is there failure to pass the curved probe to render its free end visible by oral inspection, but a difference in the distance traversed by the probe on the two sides will be noted. This may be appreciable and is usually of about 2 cm. (Boulay, Schönstadt). Confirmation by anterior and posterior rhinoscopy will follow and there is rarely need to apply digital or injection methods. The patient of Didier and Reverchon noticed that when he smoked a cigarette, he could pass the smoke through one, but not both nostrils. This might be the basis of a simple auxiliary test in adults.

## Prognosis

The prognosis of choanal atresia is determined by the grade and also, more directly, by the time taken to recognize and treat the condition. Bilateral atresia, whether complete or incomplete, is generally associated with urgent symptoms, shortly after birth. The records do not confirm, however, the gloomy outlook of Mouret and Casejust, who maintained that complete bilateral atresia is incompatible with life, and recovery from incomplete atresia a rare event. This, as already shown, is incorrect. Survival, even into adult life, is possible in the absence of any treatment, but it will be found that most of these patients had had a stormy infancy and, in general, early treatment is imperative. This is necessary, if not to save life, to avert the onset of complications which, when they supervene, have their usual prognosis.

Unilateral atresia, as might be expected, is rarely associated with urgent symptoms, and the records of only two fatal cases are found. Lange's patient probably died as a direct result of operation, and Kleyn's patient died of pneumonia when aged four months. On the other hand, four infants, of under one year, with unilateral atresia, were cured (Binnerts, Brunk, Richter and Schönstadt).

Choanal folds are usually undetected and, in the absence of treatment, have at all times a favourable prognosis.

Operative treatment almost always gives immediate relief, Texier's third case (1906) being the exception in that no improvement followed perforation of the partitions. Simple opening of the choanae may effect complete cure but, as shown, for example, by Brady and by Kearney, reclosure by scar tissue is to be expected unless more radical measures, notably the removal of part of the vomer with the partition, are practised.

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## Treatment

The treatment of choanal atresia depends, primarily, on the age of the patient, and whether the obstruction is bilateral or unilateral. The latter, in the infant, is likely to escape notice until later in life, but the former presents a different, more serious, and, at times, an urgent problem. The choice of method with these infants lies between an immediate attempt to make a nasal airway or the establishment of mouth breathing and the maintenance of nutrition, operative measures then being deferred until a later date. Opinion is not uniform, but immediate operation is here believed the better course. The risks of asphyxia and, as Hart and Peeler suggest, also well illustrated by our first patient, of sinus infection, outweigh the difficulties and risks of operative treatment of these small patients. Moreover, if it be decided to temporize, serious difficulty may be experienced in maintaining an efficient oral airway, until mouth breathing is acquired. Either relays of nurses, constantly in attendance for several days, would be required, or, alternatively, an infallible gag has to be devised; failure to maintain the oral airway, even for short periods, may prove fatal. Bilateral atresia in the adolescent or adult is never an urgent condition, and its radical cure is a matter for convenient arrangement.

Operative treatment has two objects, namely, the formation of a nasal airway, by destroying the partition and, less easy to effect, the prevention of reclosure by granulation tissue. Although this did not occur in our second case, it is frequently reported. Bourgeois and Poyet devised a two-stage operation; in the first they removed part of the bony partition and allowed scarring to occur, in order that a satisfactory permanent opening could be readily made by simple cauterization, at a later date.

Lemere stressed that simple perforation was the best method and, indeed, this is a relatively simple task if the partitions be membranous. The cautery, bistoury or trochar are then likely to be successful, especially if followed by dilatation with forceps or bougies, dilatation being repeated at suitable intervals to prevent reclosure.

When perforating the partition, it may be desirable to insert a finger into the post-nasal space to prevent the instrument from passing into the skull, but this accident seems less likely to occur than is injury to the finger of the operator, as happened in Escat's experience. Hart and Peeler devised a metal shield to protect the nasopharynx, but this seems an unnecessary elaboration. Unfortunately, most partitions are composed of bone and, at times, of dense bone, which appreciably adds to the operative difficulties. Partitions of this kind call for destruction by hammer and chisel, or by burrs or trephine. Eulenstein invented a special drill for this purpose. The choice of instruments to deal with a bony obstruction will largely depend on personal preference, for there

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appears no particular advantage as between a burr, trephine or punch. Personal custom will doubtless influence a choice as between hammer and chisel, and electrically operated instruments. The method employed in our second case (O.C.L.) consisted of perforating the partition with hammer and gouge, and enlarging the opening with Hajek's bone forceps, which were guided by a forefinger in the post-nasal space. The finger also furnished an estimate of the amount of bone to be removed.

Reclosure by granulation tissue is not infrequent, and its prevention has proved a problem to which several solutions have been proposed. In the main, these are variants of three principal methods, namely, (a) the insertion of tubes or sounds in the opening, or (b) the provision of a mucosal covering for the raw edges of the artificial choana, or (c) the removal of the partition and a portion of the nasal septum.

Mechanical measures to maintain the opening date back to the first operation, when Emmert punctured the partition with a trochar and preserved the opening by inserting a catheter, which was retained for six months. More recent improvements aim at better fixation of the dilator. Hart and Peeler, for example, passed a catheter through the atresic side and then, after bringing an end through the opposite choana, fastened the two ends by a safety pin in front of the columella. Brady used a strip of gauze in a similar way, and tied it in front of the nose. These methods are here believed undesirable because foreign bodies of this kind, retained in the nose for any length of time, predispose to infection.

A group of plastic operations aims at the prevention of reclosure by covering the raw edges of the aperture with a mucosal flap or graft. White, following Katz, used the anterior mucosal covering of the partition. This tissue was dissected off the partition, except for its attachment to the outer margin, and, after perforation, the mucosal flap was folded over the raw edge. Although this covered only part of the choanal circumference, in practice it proved sufficient to prevent disabling reclosure. Cemach (1938) inserted metal tubes, 4 mm. long and 8 mm. in diameter, into the perforation, to provide a framework for the regenerating mucosa. He found, however, that it caused severe headache in one patient, and the tube had to be removed. This method also has the disadvantages that the tube may be lost, and may pass into the lower air passages, and there are the attendant risks of infection due to the presence of the foreign body.

A transpalatal or trans-oral attack on the choanal partitions has been attempted : (Schweckendiek, Phelps, Précchtel, Brunk (case 3)). The operation is described and illustrated by Schweckendiek, but it is one which has not received appreciable support. The opening of a choana by the trans-maxillary route was described by Lannois and Jacod, but so far this is a unique operation.

The radical method of choice, designed to remove the obstruction

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and, at the same time to prevent reclosure, is one which combines perforation of the partition and removal of a portion of the posterior part of the nasal septum : (Symonds, Siebenmann, v. Eicken, Uffenorde, St Clair Thomson and others). After perforating the partition by hammer and gouge, or electric burr, as described above, the posterior part of the septum is chipped away with a curved chisel, or nibbled away by Hajek's forceps ; the main part of the septum is left in situ. The results of this operation are consistently satisfactory, as illustrated by its cure of our second patient.

### CASE I. P.M. 4731.

*Bilateral membranous choanal atresia, complicated by right antral sinusitis and orbital cellulitis : death from pyæmia ; female aged 3 months.*

This female infant, born July 3rd, 1944, was the first child of a woman aged 37. Labour, conducted at full-term, required a mid-forceps operation. Although the birth was a little delayed, the infant appeared healthy ; it weighed 6 lbs. 8 ozs. and was 20 inches long. No asphyxia was noted, and the condition of the infant immediately after birth was "satisfactory". During the first day, however, she became dyspnoeic and oxygen and CO<sub>2</sub> were administered, without relief. Early next day a large plug of mucus was removed from the nose and much mucus was "coughed up". The infant breathed with difficulty but, during the day, although fretful, she was less distressed. She slept well on the night of July 4th-5th, but in the morning, blood-stained mucus was discharged from the nose and mouth. She had frequent breast feeds, at 2-hourly intervals, on July 5th, but appeared to have difficulty in swallowing. On July 6th she began to vomit after every feed. Bottle feeding was begun on July 7th. At this time the nasal discharge was purulent ; an examination for K.L.B. was negative. Although she continued to have some difficulty in swallowing, and a slight nasal discharge persisted, she began to improve, and took feeds well. On July 11th, she had frequent watery stools and pyrexia to 100.2° F. ; there was a fair amount of nasal discharge. Mouth breathing was persistent and ascribed to nasal obstruction caused by the purulent discharge. Sulphonamide powder insufflation proved ineffectual.

The record is interrupted as between July 11th and September 24th, when she was re-admitted to hospital on account of orbital cellulitis. There was swelling and redness of the right eyelids, with proptosis of the right eye ; she had a purulent blood-stained nasal discharge. Pus was aspirated from the right upper lid and contained *S. aureus*. The lid was incised to drain the pus. Two days later a firm swelling, caused by inflammation, formed between the zygoma and the right side of the nose. Drainage was attempted by the intra-nasal route, but

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cellulitis continued to extend and the patient died on September 30th, 1944.

Post-mortem examination, on October 2nd, confirmed the presence of cellulitis of the right upper eyelid, in which there was a small surgical incision for drainage, and of the orbit. A little pus, containing *S. aureus*, was expressed from the eyelid. The nasal structures were removed by the method described elsewhere (Polson, 1942b), and an initial examination proved nasal obstruction to be caused by bilateral choanal atresia. There were pyæmic abscesses, some half dozen, in each lung, situated immediately beneath the pleura. These were areas of wedge-shape, dull red in colour, greyish at the centre. There was a suppurative pericarditis and the visceral pericardium was obscured by a fibrino-purulent layer. *S. aureus* was demonstrated in pus from the pericardium and a lung abscess.

Detailed examination of the nasal structures showed that each choana measured  $3\cdot5 \times 7\cdot0$  mm. in their transverse and vertical diameters, respectively, the choanal index being 50. A membranous partition, approximately 1·0 mm. thick and translucent, completely occluded each choana, being inserted just in front of the orifice. Below insertion into the nasal floor was at a point approximately 1 to 2 mm. in front of the posterior end of the vomer. The partitions were pale, and now of greyish tint; each surface was covered by a layer of mucous membrane otherwise indistinguishable from that covering adjacent structures. There was no scarring but, on the posterior surface of each partition, situated almost precisely at the centre, there was a small circular depression, approximately 1·0 mm. in diameter and 0·5 mm. deep (fig. 3). When held to the light, it seemed that the partition was unduly thin in the floor of the depression, but no perforation was detected.

The right maxillary antrum contained a small amount of pus, with *S. aureus*, and its lining was swollen to about 1 mm. thick, and congested. All the other sinuses were healthy.

Microscopical study of the nasal structures was undertaken by the following procedure. The block of nasal tissues was sawn into five coronal slices, each approximately  $\frac{1}{4}$  inch thick, and after decalcification and paraffin embedding, sections, approximately  $10 \mu$  thick were prepared and stained by haemalum and eosin; Weigert's haemalum and Van Gieson, and Masson's staining methods were used. The fifth slice, bearing the partitions, was bisected, and serial sections were prepared from one half, so as to traverse the whole of the partition at right angles to its anterior and posterior surfaces.

The first slice included part of the orbit, and the ethmoid region. Traces of inflammation were present in the fatty tissues of the right orbit, but the greater part of this change lay anterior to the limits of the block of tissue removed for histology. There was no abnormality

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of the optic nerves or other structures. The second slice included the ethmoid region and the upper two turbinates. There was moderate inflammation of the submucosa of the outer nasal wall on the right side, but no other abnormality of note. The third and fourth slices, through the mid-point of the lower turbinate body and just behind its posterior end, respectively, included the inner walls of the antra. These sections confirmed the presence of inflammation of the right antral mucosa. The anatomical structure of the parts was otherwise normal ; there was no septal deflection and the palate was symmetrical.

The fifth slice, examined by serial sections, demonstrated that the partition was complete, no perforation existing even in the dimple. The partition was essentially membranous throughout, and contained no trace of bone or cartilage (figs. 4 and 5). The epithelial covering of each surface was largely removed by the process of preparation, but small fragments of ciliated columnar epithelium were identified on each surface. The submucosa of the anterior surface contained mucous secreting glands, identical with those plentiful around the Eustachian cartilage. The fibrous layer was of hyaline connective tissue without any trace of inflammation, either recent or old, (fig. 5). A small portion of hard palate, included in the specimen, had the normal structure. The partition was inserted into the palate a short distance anterior to the posterior end of the septum.

It was concluded that secretion, retained on account of choanal atresia, had become infected, and thereafter infection had spread to the right antrum and orbit, with a final phase of pyæmia, producing the abscesses in the lungs, and suppurative pericarditis.

### CASE II. O.C.L.

*Unilateral, left, bony atresia of the choana.*

E.W., a male aged 24, had complained of nasal obstruction and discharge, on the left side, ever since he could remember. Obstruction was complete, and he was unable to blow air through the nostril. The nasal discharge, which was muco-purulent, could not be blown out and excess had frequently to be wiped away. He was first seen, elsewhere, in 1940, and submucous resection of the septum was performed ; the left antrum was also irrigated but the washings were normal. Unilateral atresia was detected, but its treatment was deferred, the patient being told to return in a month's time.

He became an outpatient in the General Infirmary at Leeds, during January 1942 ; his condition was then as follows : the left nasal fossa was roomy, on account of partial atrophy of the turbinate bodies. Mucus secretion was abundant on this side. Atresia of the left choana, due to the presence of a partition, which appeared bony to the probe,

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was seen by anterior and post-nasal examination. From the latter aspect, obstruction was complete, and the partition was flush with the posterior end of the septum. No dimple was seen ; on the contrary, the center of the partition projected backwards by about 2 to 3 mm. behind the posterior septal edge. There was anosmia. The right nasal structures were healthy ; the sinuses were clear to transillumination ; there was no abnormality in the ears, and his hearing was normal.

At operation, under general anaesthesia, on January 27th, the bony partition was perforated by hammer and gouge, and the opening enlarged, as much as possible, by bone forceps ; a portion of the margin of the vomer, forming the posterior part of the bony septum, was also removed. The partition was bony throughout and ranged in thickness from 1 to 2 mm. centrally, and was about 3 mm. at its periphery. An adequate airway was established, the aperture having a bare, bony margin. His post-operative progress was entirely satisfactory, and he was kept under observation, as an outpatient, until May 1942, by which time his nose had healed. He was re-examined in November 1944, in order to assess the end-results of operation. He said there had been no nasal symptoms since his operation, and his sense of smell had returned. Examination showed a free passage through the left nose, which was clear of discharge ; he had no difficulty in blowing his nose. The nasal mucosa and the turbinate bodies were healthy. After shrinking the mucosa, anterior rhinoscopy showed that the left choana was open in its lower part, the lumen being at least 1.5 cm. in diameter ; a bridge of tough, fibrous membrane persisted across the upper third of the choana, whose margin was now completely covered by mucous membrane. These findings were confirmed by posterior rhinoscopy. Since no further reduction in the size of the left choanal opening was anticipated, and the patient was symptomless, it was unnecessary to undertake further treatment. The presence of scarring of the left tympanic membrane, now present, was ascribed to an attack of otitis media, which he had had early in 1944, and was in no way connected with his former nasal trouble.

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- ALONSO, J. M., and REGULES, E., *Rev. méd.*, Uruguay, 1919, xxii, 201-03, *Index-Cat. Surg. Gen.*, right choanal atresia.
- ALTMANN, F., *Z. Hals-Nas.-u. Ohrenheilk.*, 1931, xxix, 308-22 ; bilateral bony atresia, F., premature, 7th. month.
- ANDERSON, C. M., *J. Amer. med. Ass.*, 1937, cix, 1788-92 ; six cases, four M. two F. ; four unilateral, two R., two L. ; three bony, one membranous, one mixed, one not stated.

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- ARANABIA, F., and FUMASOLI, C., *Rev. Asoc. méd. argent.*, 1934, xlvi, 1445-46; sect. Nipiol., 243-44; right atresia, M. 2 months; skiagram.
- ARD, F. C., *Laryngoscope*, St. Louis, 1907, xvii, 312; bilateral bony atresia.
- ARNOLD, J., *Virchows Arch.*, 1867, xxxviii, 145-72; bilateral atresia in a foetus.
- ARSLAN, Y., *Boll. Mal. Orecch.*, 1897, xv, 106-08; right bony atresia, M. 13.
- ASCH, M. J., cited Mayer, 1893; bilateral bony atresia, M. 25.
- ASHERSON, N., *J. Laryng.*, 1930, xl, 344-46; bilateral membranous atresia, F. 35.
- ATTAL, M., *Thèse Paris*, 1911; right membranous atresia, F. 11, and précis of nine cases of other authors.
- BABER, E. C., *J. Laryng.*, 1894, viii, 143-45; also, in discussion, *Proc. R. Soc. Med.*, 1908-09, ii, Laryng. Sect., 20; right mixed atresia, M. approx. 6.
- BALL, J. B., *J. Laryng.*, 1895, ix, 506, right bony atresia, F. 21.
- BALLA, A., *Arch. ital. Otol.*, 1907, xxvii, 113-42; right mixed atresia, F. 25; and table of published cases.
- BARBERA, S., *Oto-rino-laryng. int.*, 1936, vi, 536-76; right atresia, M. 17; left membranous atresia, F. 44.
- BARRAUD, *Schweiz. med. Wschr.*, 1920, 1, 654; two cases of atresia in adults.
- BARWELL, H., *Proc. R. Soc. Med.*, 1908-09, ii, Laryng. Sect., 20; right atresia, F. 25.
- BAUMGARTEN, E., *Orv. Hetil.*, 1889, xxxiii, 44, *Index Medicus*; also trans., *Pester. med.-chir. Pr.*, 1889, xxv, 1300; also abstr., *Wien med. Wschr.*, 1889, xxxix, 2040, and *J. Laryng.*, 1890, iv, 127, bilateral membranous atresia, F. 31; *Mschr. Ohrenheilk.*, 1896, xxx, 17-20; right bony atresia, F. 9; incomplete bilateral mixed atresia, F. 40, bilateral fibrous atresia, F. 30; *Ibid.* 1898, viii, 404-05, incomplete bilateral bony atresia, M. 14; left bony atresia, M. 18; also *Pester. med.-chir. Pr.*, 1906, xlvi, 404, *Index-Cat. Surg. Gen.*, unilateral bony atresia.
- BAUROWICZ, A., *Arch. Laryng. Rhin. Berl.*, 1901, xi, 150-53; bilateral bony atresia, M. 22.
- BEAUSOLEIL, R., *Bull. Soc. Anat. Physiol.*, Bordeaux, 1893, xiv, 174-81; *J. méd. Bordeaux*; *Index-Cat. Surg. Gen.*, cited Haag: Daubret: Mackenty; right complete and left incomplete bony atresia, F. 11.
- BELLIN and LEROUX, cited Attal: Balla: Theessen; incomplete bilateral membranous atresia, M. 24.
- BENNETT, O. P., *Ann. Ophthal. Otol.*, St. Louis, 1893, ii, 51-53; *Index Medicus*; cited Haag, right bony atresia.
- BENTZEN, S., *Ugeskr. Laeg.*, 1903, 5R., x, 457-67; *Index Medicus*; cited Kahler: Brunk, bilateral bony atresia, F. 30.
- BERBLINGER, W., *Arch. Laryng. Rhin. Berl.*, 1917-18, xxxi, 632-47; bilateral mixed atresia, F. 5 months; bibliography.
- "BETTS", cited Schroetter: Mackenzie, M., see "Bitot", for correct reference. Error first detected by Knight 1889.
- BLYNES, E., *Arch. int. Laryng.*, 1928, vii, 179-83; left mixed atresia, F. 20.
- BILANCIONI, G., *Arch. ital. Otol.*, 1916, xxvii, 342-55; left bony atresia, F. 13; bibliography.
- BINNERTS, A., *Arch. Laryng. Rhin. Berl.*, 1921, xxxiv, 324-46; left bony atresia, infant, 3 months.
- BINSWANGER, H., *Munch. med. Wschr.*, 1909, ii, 2634-35; left bony atresia, F. 13.
- BIRKETT, cited Kahler; right bony atresia, F. 8; *ibid.*, F. 23.

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- BLEYL (Nordhausen), *Z. Ohrenheilk.*, 1902, xl, 54-59; right bony atresia, F. 17.
- BONHAM, W. L., *Sth. med. J.*, Nashville, 1942, xxxv, 252-57; right bony atresia, F. 15; bilateral bony atresia, F. 23 (initial operation on 4th. day of life); skiagrams.
- BORGHESEN, E., *Valsalva*, 1938, xiv, 73-75; *Index Medicus*; cited Martini; contribution to the operative treatment of atresia.
- BOTEY, R., *Ann. Mal. Oreil. Laryng.*, 1906, xxxii, 374-80; right bony atresia, F. 19.
- BOULAI, (Rennes), *Arch. int. Laryng.*, 1901, xiv, 407-10; right bony atresia, F. 14; *ibid.*, F. 14.
- BOULAY, M., *Arch. Méd. Enf.*, 1902, v, 140-56; right bony atresia, F. 11; *ibid.*, F. 18.
- BOURGEOIS, H. and POYET, G., *Acta Oto-laring.*, Stockholm, 1925, vii, 568-86 (pp. 582-83); three incomplete reports.
- BOWSER, *Amer. Med.*, 1910, xvi, N.S.V., 283; in discussion, three cases; scanty details.
- BOYD, H. M. E., *Arch. Oto-laryng.*, Chicago, 1945, xli, 261-271; bilateral bony atresia, M. 20.
- BRADY, A. J., *J. Laryng.*, 1918, xxxiii, 49-50; bilateral bony atresia, F. 16½ (first treated when 8½); *ibid.*, F. 18 (first treated when 8).
- BRANDIES, R. C., *N.Y. J. Med.*, 1881, xxxiv, 517; left bony atresia, F.
- BRIANI, A., *Boll. Mal. Orecch.*, 1927, xlv, 28-32; bilateral membranous atresia, F. 33; *ibid.*, F. 44; both syphilitics and atresia presumably acquired.
- BROSE, L. D., *Ann. Otol., etc.*, St. Louis, 1907, xvi, 135-37; right bony atresia, M. 22.
- BROWNELL, D. H., *Univ. Hosp. Bull. Ann. Arbor*, 1939, v, 68; no case report.
- BRUNK, A., *Z. Ohrenheilk.*, 1909, lix, 73-91 and *ibid.* 221-24; right atresia, F. 11 weeks; right bony atresia, F. 14, and left bony atresia, F. 20.
- CALAMIDA, U., *G. Accad. Med.*, Torino, 1904, 4S., x, 326-28; *Index-Cat. Surg. Gen.*; case of bony atresia.
- CAMPO, F., *Ann. Med. nav. colon.*, 1926, ii, 48-51; *Index-Cat. Surg. Gen.*; right bony atresia.
- CARRIL, A. V. DEL, *Rev. Asoc. méd. argent.*, 1938, lii, 977-79; *Index Medicus*; case of unilateral atresia.
- CASADESUS (Barcelona), *Ann. Oto-laryng. Par.*, 1933, No. 12, 1442; in discussion, 3 cases mentioned, one being of bilateral atresia in the newborn.
- CASSELBERRY, W. F., *J. Amer. med. Ass.*, 1885, v, 148-50; also *Trans. Amer. Laryng. Ass.*, 1913, XXXV, 229-30, in discussion; incomplete bilateral membranous atresia, M. circa 40; mixed atresia, infant 6 months and unilateral atresia, M. 24.
- CASTAÑEDA, B., ROCCATAGLIATA, R., and GARZONI, J., *Rev. méd. lat.-amer.*, 1935-36, xxii, 1028-30; left mixed atresia, F. 14.
- CASTEX, *Rev. Laryng.*, Paris, 1906, i, 742-44; in discussion, right membranous atresia, F. 19.
- CAVANAUGH, J., *Ann. Otol., etc.*, St. Louis, 1923, xxxii, 1254; in discussion, case of atresia, child, 12.
- CEMACH, A., *Mschr. Ohrenheilk.*, 1938, lxxii, 914; in discussion, on surgical measures; no case report.
- CENTENO, R. R. and TATO, J. M., *Rev. Asoc. méd. argent.*, 1934, xlvi, 36-7; also *Hosp. argent.*, 1934, iv, 569-70; *Index Medicus*, right bony atresia, M. 19.

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- CHAROUSEK, G., *Arch. Ohr.-Nas.-u. Kehlk.-Heilk.*, 1922-23, cx, 209-21; left bony atresia, F. 23; incomplete bibliography.
- CHAUVEAU, L., *Gaz. Mal. inf.*, 1900, ii, 201-05, *Index-Cat. Surg. Gen.*, "L'Obstruction nasale chez le nouveau-né".
- CHIARI, O., *Wien med. Wschr.*, 1885, xxxx, 1473 *Index Medicus* and Chiari, 1909; bilateral membranous atresia, F. 70, also *Wien. laryng. Ges.*, 1895, cited Hérisset, *Thèse Paris*, 1904, p 30, left bony atresia and rhinolith; F. 50; also *Wien. med. Wschr.*, 1909, lv, 561-69, retro-nasal membranous atresia, F. 50, and classification of atresia.
- CHILDREY, J. H., *Laryngoscope*, St. Louis, 1938, xlvi, 51-53, right bony atresia, F. 19.
- CINELLI, A. A., *Ann. Otol., etc.*, St Louis, 1940, viii, 912-23; review, no case report
- CÍSLER, J., *Čas. Lék. česk.*, 1912, li, 475-77, translation by Professor H. Šíkl; right bony atresia, M 13
- CITELLI, S., *Arch. Ital. Laryng.*, 1902, xxvii, 120-24, right bony atresia, F. 32; left bony atresia, F. 8.
- CLAOUÉ, *Rev. hebdom. Laryng.*, 1905, xxv, 717, abstr. *Gaz. Sc. méd. Bordeaux*, 1905, No. 2 (ardenne), right bony atresia, F young
- CLARK, E. E., *Cincinnati Lancet-clin.*, 1896, xxxvi, 336, *Index-Cat. Surg. Gen.*, case of bilateral atresia
- CLARK, J. P., *Boston med. Surg. J.*, 1898, cxxxviii, 171-74, bilateral bony atresia, F. 18, *ibid.*, 1908, cliv, 447-48, "Anomalous folds in the naso-pharynx".
- CLAY, J. V. F., *Hahnemann Mon.*, 1916, li, 127-29, *Index-Cat. Surg. Gen.*, case of atresia.
- COAKLEY, C. G., *Trans. Amer. laryng. Ass.*, 1913, xxxx, 230, in discussion, case of atresia mentioned
- COHEN, J. SOLIS-, "Diseases of the Throat and Nasal Passages", Wood & Co., New York, 1872, pp 295-96, bilateral atresia, infant.
- COHN, G., *Mschr. Ohrenheilk.*, 1904, xxviii, 472-89, left bony atresia, M. 10; table of published cases
- COLVER, B. N., *Trans. Amer. laryng. Ass.*, 1920, xxvi, 276-86, bilateral bony atresia, F 2, 8/12, also *Ann. Otol., etc.*, St. Louis, 1937, xlvi, 358-75; bilateral bony atresia, F 6 days, and republication of former case
- CRULL, Z. *Ohrenheilk.*, 1895-96, xxviii, 133-35, left bony atresia, M. 5.
- D'AGUANNO, A., *Arch. Ital. Otol.*, 1897, v, 231-35, right fibrous atresia, F. 17.
- D'AMBROSIO, *Progresso Medico*, Napoli, 1890, iv, 309-11, *Index-Cat. Surg. Gen.*, "Stenosi congenite delle fosse nasali".
- DAUBRET, M. V., *Thèse Paris*, 1900, No 572, p 32, right bony atresia, F. adult; Grossard's patient
- DAVIS, A. D., pers. commun to Donnelly, unilateral bony atresia, F. 25.
- DAVIS, H. J., *J. Laryng.*, 1910, xxv, 137, mention of a case of atresia in discussion; no details
- DEAN, L. W., *J. Amer. med. Ass.*, 1925, lxxv, 317-32, discussion 320-21; general statement that all cases of atresia in his experience had sinus disease. See also Prentiss.
- DECKER, P. H., *Atlant. med. J.*, 1925-26, xxix, 461; *Index-Cat. Surg. Gen.*, case of unilateral bony atresia.
- DENNIS, F. L., *Colo. Medd.*, 1911, viii, 130-33, *Index-Cat. Surg. Gen.*; "Congenital bony atresia of the choana".

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- DICORE, A., *Rass. ital. Oto-rino-laryng.*, 1932, vi, 169-78; *Index Cat. Surg. Gen.*; right bony atresia; adult.
- DIONISIO, I., *G. Accad. Med.*, Torino, 1895, xlvi, 137-39; *Index-Cat. Surg. Gen.*, and Daubret; case of bilateral membranous atresia.
- DONNELLY, J. C., *Arch. Otolaryng.*, Chicago, 1938, xxviii, 112-25; right bony atresia; F. 4.
- DOWNIE, W., *Glas. med. J.*, 1896, xlvi, 299-301; a case of anterior nasal atresia.
- EGBERG, 1877; cited Bilancioni; "Occlusio choanorum".
- EICKEN, VON (GIESSEN), *Verhandl. d. Ver. dtschr. Laryng.*, Wurzb., 1911, 593-600; acquired left atresia, F. 48; right bony atresia, F. 20.
- ELMIGER, G., *Schweiz. med. Wschr.*, 1922, lii, 497-98; left bony atresia, F. 10; *ibid*, F. 30 and *ibid*, M. 9.
- EMMERT, C., "Lehrbuch d. Chir.", Stuttgart, 1853, Bd. II, S.535; cited Luschka and others; bilateral bony atresia; M. 7; first clinical report and surgical cure.
- ENGELL, K., Leipzig, 1913; *Index-Cat. Surg. Gen.*; "Die Atresie der Choanen und ihre Behandlung".
- ESCAT, E., *Arch. internat. Laryng.*, May and June 1896; abstr. *J. Laryng.*, 1896, xi, 29 (Joal), also *ibid*, pp. 297-98 (Waggett); bilateral atresia, M. 22; *ibid*. M. 11, and *ibid*. M. 56; also *Arch. méd. Toulouse*, 1912, xix, 102-07; *Index-Cat. Surg. Gen.*; Deux cas d'occlusion congénitale des choanes; also *Ann. Otolaryng.*, Paris, 1933, No. 12, 1443, in discussion; reference to personal cases.
- EULENSTEIN, H., *Dtschr. med. Wschr.*, 1889, xv, No. 39, 800-01; bilateral bony atresia; F. 36.
- EVANS, A., *Lancet*, 1924, i, 1002; bilateral bony atresia; M. 3 weeks.
- FALLAS, Dem. Soc. Brux. *Oto-rhino-laryng.*, March 25th, 1927; rep., *Rev. Laryng.*, Paris, 1928, vii, 1199; right atresia, child, 10.
- FEIN, J., Dem. Wien. laryng. Gesellsch.; rep., *Wien. klin. Wschr.*, 1907, xx, No. 4, 121; left bony atresia; F. 45, also dem. Wien. laryng. Gesellsch., October 8th, 1910, cited Berblingier; case of bilateral congenital atresia.
- FELDMANN, 1922; cited Vogel; right bony atresia.
- FERNÁNDEZ, V. J., *Gac. méd. Norte*, 1912, xviii, 5-8; *Index-Cat. Surg. Gen.*; bilateral membranous atresia.
- FEUCHTINGER, *Mschrr. Ohrenheilk.*, 1920, liv, 119-120; right bony atresia; M. 25.
- FISHBEIN, J. N., *R.I. med. J.*, 1931, xiv, 180; *Index Medicus*; case of choanal atresia.
- FLATAU, T. S., *Dem. Wien. klin. Rundschau*, 1899; rep., *J. Laryng.*, 1900, xv, 47-48; right bony atresia; F. 40.
- FRÄNKEL, B., 1889, cited Haag and Vogel; bilateral bony atresia, M. 18.
- FRASER, J. S., *Brit. med. J.*, 1910, ii, 1698-1701; right bony atresia, F. 20; autopsy report and review of 115 cases.
- FRAZER, J. E. S., *J. Anat., Lond.*, 1911, xlvi, 347-56; "A preliminary communication on the formation of the nasal cavities".
- FRÈCHE, 1894; cited Hamilton, T. K.; bilateral atresia; adult; syphilitic.
- FRITTS, J. R., *Trans. med. Ass.*, Missouri Kansas City, 1898, pp. 145-53; *Index-Cat. Surg. Gen.*; "Occlusion of the posterior nares, congenital (bony)".
- GALAND, G., *Ann. Mal. Oreil. Larynx.*, 1924, xlivi, 1045-46; bilateral bony atresia; newborn child.
- GARRETSON, W. T., *Laryngoscope*, St. Louis, 1927, xxxvii, 263-68; right bony atresia, F. 16, and right mixed atresia, F. 12.

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- GIANNONE, A., *Boll. Mal. Orecch.*, 1918, xxxvi, 73-76; incomplete bilateral membranous atresia, F. 39, and right fibrous atresia, F. 45.
- GILSE, P. A. G. VAN, *Nederl. Tijdschr. Geneesk.*, 1935, lxxix, 5536-40; *Index Medicus*, also *Acta. Otolaryng.*, Stockholm, 1936, xxiv, 205-08; ciné demonstration of bilateral atresia; newborn infant.
- GLAS, E., *Mscr. Ohrenheilk.*, 1926, lx, 494; right bony atresia, F. 22.
- GOSSELIN, *Bull. acad. méd.*, 1876, v, 883; right bony atresia, F. 18.
- GOTTSTEIN, 1887; cited Haag; dem. of bony atresia.
- GOUGENHEIM, A., and HÉLARY, L., *Ann. Mal. Oreil. Larynx*, 1894, xx, 43-59; *Index-Cat. Surg. Gen.*; précis by Attal, and abstr. *J. Laryng.*, 1894, viii; left bony atresia, F. 15.
- GÖZ, A., *Z. Ohrenheilk.*, 1913, lxviii, 43-48; bilateral bony atresia, F. newborn; right membranous atresia, F. 33; left bony atresia, F. 15; right bony atresia, F. 28, and right atresia, M. 29.
- GRADENIGO, G., *G. Accad. Med.*, Torino, 1897, 3s., xlvi, 717-20; *Index-Cat. Surg. Gen.*; cited Baurowicz; right bony atresia, M. 18.
- GRANT, J. DUNDAS, *J. Laryng.*, 1894, viii, 155-56; right atresia; F. treated at birth; recurrent fibrous stenosis at 27; also *Proc. R. Soc. Med.*, 1919-20, xiii, *Laryng. Sect.*, 34-35 and *Brit. J. Child. Dis.*, 1920, xvii, 98; left mixed atresia, F. young.
- GREIF, Čas. Lék. čes., 1923, xli, 1254; right bony atresia; scanty details (per Professor Šíkl).
- GROVE, R. C., *Virginia med. (Semi-)Mon.*, 1934, lx, 682-84; right bony atresia; F. 20.
- GROVE, W. E., *Arch. Otolaryng.*, Chicago, 1927, vi, 237-41; right bony atresia, F. 48.
- GUTTMAN, J., *Amer. Med. Philad.*, 1910, xvi, N.S.v, 283; case of unilateral bony atresia.
- GUYE, *Dutch Soc. Laryng.*, 1894, July; rep., *J. Laryng.* 1895, ix, 465-66; in discussion; case of right bony atresia.
- HAAG, H., *Arch. Laryng. Rhin.*, Berl., 1899, ix, 1-29; bilateral membranous atresia, F. adult; bilateral osseo-membranous atresia, F. 13 and bilateral bony atresia, F. 20; bibliography and table of published cases; key paper.
- HAJEK, M., *Wien. klin. Wschr.*, 1902, xxv, 221; in discussion, mention of three cases treated.
- HALLE, *Verh. dtschr. laryng. Ges.*, 1911, xxi, 24, *Index-Cat. Surg. Gen.*; "Operation der Choanalatresie".
- HAMILTON, H. D., *Canad. Practit.*, 1902, xxvii, 590; right bony atresia, M. 17.
- HAMILTON, T. K., *J. Laryng.*, 1905, xx, 172-78; bilateral bony atresia, F. 35; *ibid.* M. 28; left bony atresia, F. 50, and *ibid.*, F. 7.
- HANAUSEK, J., *Čas. Lék. čes.*, 1910, xl ix, 1307: 1346; abstr. by Professor Šíkl; left atresia, F. 18.
- HANSZEL, *Wien. klin. Wschr.*, 1902, xxv, 221; in discussion, case of right mixed atresia.
- HART, V. K., *Sth. med. J.*, Nashville, 1926, xix, 703; bilateral bony atresia, F. 21.
- HART, V. K., and PEELER, C. N., *Sth. med. J.*, Nashville, 1929, xxii, 1087-88; bilateral bony atresia; F. 11 hours.
- HECHT, Dem. Soc. Oto-laryng., Munich, 3 March, 1902; rep., *Rev. Laryng.*, Paris, 1902, ii, 655-56; right membranous, ?acquired, atresia, M. 15; congenital lues; also *ibid.*, 1906, i, 165-66; bilateral membranous atresia, F. 29 and left bony atresia, F. 26.

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- HÉRISSET, *Thèse Paris*, 1904, p. 30 (see Chiari, 1895).
- HEYMANN, P., *Berl. klin. Wschr.*, 1904, xv, No. 41, 935; dem. of anatomical specimen of bony atresia.
- HEYSE, Leipzig, 1900; cited Berblingher; "Anomalien der Choanen und des Cavum pharyngonasale".
- HINOJAR, cited Beynes; no details.
- HOCHHEIM, K. E. H., Griefswald, 1903; *Index-Cat. Surg. Gen.*, cited Brunk, Kahler and White; bilateral bony atresia, M. ?age.
- HOCHSTETTER, F., *Verh. anat. Ges. Jena*, 1891, v, 145-151; *Index Medicus*; "Ueber die Bildung der inneren Nasengänge oder primitiven Choanen".
- HOPMANN (Cologne); *Arch. klin. Chir.*, 1888, xxxvii, 235-63; cited Hopmann, 1894; right bony atresia, F. 12; *ibid.*, M. 19; also *Arch. Laryng. Rhin.*, *Berl.*, 1894, i, 359-62; right bony atresia, M. 41 and left bony atresia, M. 15; also *ibid.*, 1895, iii, 48-67; "Anomalien der Choanen und des Nasenrachenraums".
- HOVORKA, 1892; cited Daubret; case of unilateral bony atresia.
- HUBBELL, A. A., *Buffalo med. J.*, 1886-87, xxvi, 193-206; bilateral bony atresia, M. 18; review of 16 published cases.
- HUTTER, FR., *Dem. Wien. Laryng. Gesellsch.*, 1st February, 1938; rep., *Msch. Ohrenheilk.*, 1938, lxxii, 1002; right bony atresia, F. 22.
- INGERSOLL, J. M., *Ann. Otol., etc.*, St. Louis, 1904, xiii, 189-96; "A study of the development of the nose and its accessory cavities".
- IWANOFF, A., *Arch. Laryng. Rhin.*, *Berl.*, 1904, xvi, 332-35, cited Mackenty, Theessen and Vogel; "Beitrag zur Kasuistik der Choanalatresien".
- JACQUES, P., *Rev. Laryng.*, Paris, 1921, xlii, 607-12; mixed atresia, M. 19; *ibid.* M. 11, and right complete and left incomplete osseo-membranous atresia; M. 18, luetic.
- JAMES, W. W., and HASTINGS, S., *Proc. R. Soc. Med.*, 1931-32, xxv, 1343-53; Discussion on Mouth Breathing and Nasal Obstruction; bibliography, but no case report.
- JARVIS, W. C., *Trans Amer. laryng. Ass.*, 1888, ix, 222-30; "Two unique cases of congenital occlusion of the anterior nares".
- JOËL, E., *Z. Laryng. Rhinol.*, 1898, xxxiv, 25-29; *Index Medicus*; also trans. (Spalding, J. A.), *Arch. Otol.*, N.Y., 1899, xxviii, 32-34; left mixed atresia, F. 22.
- JOHNSTON, R. H., *J. Amer. med. Ass.*, 1906, xlvi, 686-87; "Congenital membrane in the naso-pharynx".
- JONES, J. A., *Lancet*, 1922, ii, 327-28; mention of a few cases seen but none under 1 year.
- JUFFINGER, *Wien. klin. Wschr.*, 1901, xiv, 881; bilateral bony atresia; F. 18.
- KAFEMANN, A. W., and BESELIN, O., *Arch. Ohr.-Nas.-u. Kehlk. Heilk.*, 1926-27, cxvi, 116-18; four unilateral cases; 2 F., 2 M., 2 R., 2 L.; aged 14, 16, 20 and 21 years; all of bony atresia.
- KAHLER, O., *Msch. Ohrenheilk.*, 1909, xlivi, 41-67; nine cases from Chiari's Clinic; 8 F. 1 M.; 2 bilateral and 7 unilateral (5 R., 2 L.); all bony atresia except Case 9 (right, mixed atresia); key paper.
- KAMM, 1902; cited Vogel; "Ein Fall von Verschluss der hinteren Nasenöffnung".
- KAYSER, R., *Wien. klin. Wschr.*, 1899, xiii, 167; *Index-Cat. Surg. Gen.*; abstr., *J. Laryng.*, 1899, xiv, 430; right atresia; ?24; also Heymann's *Handbuch Laryng. Rhin.*, 1900, iii, 610-33; "Verwachsungen der Nase (Synechien und Atresien)".

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- KAZANJIAN, V. H. and BROWN, L. A., *Arch. Otolaryng., Chicago*, 1937, xxvi, 777-78; left bony and right mixed atresia; F. 13; (Apparently republished as Case 1 in 1942, see Kazanjian.)
- KEARNEY, H. L., *Ann. Otol. etc.*, St. Louis, 1936, xlv, 583-86; right bony atresia; F. 13.
- KEIMER (Dusseldorf); 1887; cited Haag; case of right bony atresia.
- KELLY, BROWN, *Brit. med. J.*, 1910, ii, 1701; in discussion; unilateral membranous atresia; F. 3 and *ibid.*; F. adult.
- KELLY, D. B., *Brit. med. J.*, 1939, i, 157-58; left bony atresia, F. 20.
- KILLIAN, (Freiburg); pers. commun. to Brose; bilateral atresia; child, 3.
- KIRBY, J. C., *Laryngoscope*, St. Louis, 1921, xxxi, 701-03; right atresia; F. adult, and choanal atresia; F. 10.
- KLAFF, D. D., *Arch. Oto-laryng., Chicago*, 1945, xli, 298-99; bilateral bony atresia, M. 26.
- KLEYN, A. DE, *Acta Oto-laring., Stockh.*, 1918, i, H.1, 189-90; right ?bony atresia; suppurative rhinitis and ethmoiditis; child, 14 days.
- KNIGHT, C. H., *Trans. Amer. laryng. Ass.*, 1889, x, 102-09; right bony atresia; F. 18, and *ibid.*; no details; bibliography.
- KOCH (Johannesburg), *Transv. med. J.*, 1910, v, 206-08; bilateral bony atresia; suppurative rhinitis and sinusitis; F. 11, also *Nederl. Tijdschr. Geneesk.*, 1911, i, 2142-45; *Surg. Gen. Cat.*, "Een geval van aangeboren atresie der Choanae".
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- KREIG, R., "Atlas of Diseases of the Nose", German and English text (Roman, A.) Stuttgart, 1901, Plate 3; right bony atresia, F. 19.
- KRUSE, 1904; cited Balla; bilateral ?acquired atresia, F. 52.
- KUHF, cited Daubret; case of choanal atresia, F. 15.
- KUNDRAT, H., "Die Arhinencephalie als typische Art von Missbildung", Graz, 1882, S.41; cited Schroetter and Charousek; case of atresia, F. newborn.
- KUTVIRT, D., *Wien. med. Wschr.*, 1902, lii, 2052, bilateral bony atresia, F. 6.
- LABHARDT, E., *Schweiz. med. Wschr.*, 1936, lxvi, 1153-54; six cases, with limited details of five; all bony; all unilateral, 4 L, 1 R.; 3 F., 2 M., ages from 10-19 years.
- LACOARRET (Toulouse), 1898, cited Baurowicz and Daubret; right membranous atresia; F., young.
- LACK, L., *J. Laryng.*, 1901, xvi, 301; unilateral bony atresia in dissecting room subject.
- LAGO, E. DAL, *Boll. Mal. Orecch.*, 1940, lviii, 450-58; *Index Medicus*; "Congenital bilateral diaphragm of choana: case".
- LANG, J., *Mschr. Ohrenheilk.*, 1912, xlvi, 970-1001; right bony atresia, F. 15; *ibid.*, F. 35; *ibid.*, F. 16; three members of one family.
- LANGE, V., *Dtschr. med. Wschr.*, 1892, xviii, No. 29, 667-68; right mixed atresia; M. 19; death from ?sinus thrombosis, 6 days after operation.
- LANGMAID, J., *Laryng.*, 1895, ix, 605; in discussion, mention of three personal cases.
- LANNOIS and JACOD, *Lyon méd.*, 1917, cxxvi, 146-49; left atresia; M. adult; operation via maxilla.
- LEBENSOHN, J. E., *Ann. Otol. etc.*, St. Louis, 1923, xxxii, 1128-34; right mixed atresia; M. 23.

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- LEMERE, H. B., *J. Amer. med. Ass.*, 1937, cix, 347-48; bilateral membranous atresia; M. 2 months.
- LEMOINE, *Ann. Otol., etc.*, 1931, pp. 212-13; incomplete bilateral stenosis, F. 7.
- LESCHINSKIY, Y. L., *Zhur. ush. Nos. i Gorl. bolez.*, 1938, xv, 471-75; *Index Medicus*; "Atresia of choana: 3 cases".
- LOEB, H. W., *Trans. Amer. laryng. Ass.*, 1913, xxv, 230; in discussion; 4 personal cases of atresia mentioned.
- LOSSOW, 1922; cited Vogel; Vulowitsch; "Vortrag über Choanalatresie".
- LÜDERS, W., Griefswald, 1920; cited *Mschr. Ohrenheilk.*, 1920, liv, 1119; "Über Choanalatresie".
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- LUND, C. J., *Amer. J. Obstet. Gynaec.*, 1941, xli, 934-48, "Prevention of asphyxia neonatorum".
- LUSCHKA, H., *Virchows Arch.*, 1860, xviii, 168-70; bilateral bony atresia; M. 7; Emmert's patient; also "Der Schlundkopf des Menschen", Tübingen, 1868, S. 27; cited Schroetter; bilateral bony atresia; F. newborn.
- LUZZATI, A., *Arch. ital. Otol.*, 1921, xxxii, 22-24; *Index Medicus*; "Un caso di atresia bilaterale congenita delle coane".
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- MACKAY, M., *Montreal med. J.*, 1908, xxxvi, 266-67; bilateral atresia; F. newborn.
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- MCKENZIE, DAN, *J. Laryng.*, 1910, xxv, 137, also *Proc. R. Soc. Med.*, 1909-10, iii, Laryng. Sect., 91; left mixed atresia; F. 19.
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- McNAUGHT, H. Y., *Calif. St. J. Med.*, 1918, xvi, 193; *Index Medicus*; "Congenital occlusion of the choanae of the nose".
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- MAHONEY, P. L., *Laryngoscope*, St. Louis, 1927, xxxvii, 920; bilateral mixed atresia; M. 3 months.
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- MANGIARACINA, A., *Arch. Otolaryng.*, Chicago, 1940, xxxii, 1088-89; bilateral fibrous atresia; F. 11.
- MARSCHIK, H., *Mschr. Ohrenheilk.*, 1938, lxxii, 913-14; right mixed atresia; F. 16.
- MARTINI, R. DE, *Boll. Mal. Orecch.*, 1939, lvii, 14-22; bilateral bony atresia; F. 45; bilateral, recurrent, membranous atresia, F. 75, first operation when 45, and right bony atresia, F. 11.

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- METTENHEIMER; 1864; cited Balla; right bony atresia, F. 25.
- MEYERSOHN, S., *Medycyna*, 1887, xv, 113: 134; *Index Medicus*; cited Chiari 1909; nasopharyngeal membranous atresia; F. 37.
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- MONCRIEFF, A., *Brit. med. J.*, 1936, i, 1295-96; bilateral bony atresia; infant, newborn.
- MORF, J., *Arch. Laryng. Rhin.*, Berl., 1900, x, 173-176; unilateral mixed atresia and hyperhydrosis; M. 43.
- MORGENSTERN, D. J., *Arch. Otolaryng.*, Chicago, 1940, xxxi, 653-62; left bony atresia; F. 18.
- MORTON, T. G., *Surg. Penn. Hosp., Philad.*, 1880, p. 333; *Index-Cat. Surg. Gen.*; cited Haag after Schwendt; ?left membranous atresia; M. 8.
- MOTHE, DE LA D., *Ann. Mal. Oreil. Larynx*, 1924, xlili, 781-84; "Enorme corps étranger des fosses nasales".
- MOURE, 1887; cited Daubret; case of bilateral bony atresia; brief details.
- MOURET, J. and CAZEJUST, P., *Rev. Laryng.*, Paris, 1921, xlili, 111-131; *ibid.* 143-164; left mixed atresia; F. 13.
- NAGER, T. R., *Korresp. Bl. schweiz. Arz.*, 1915, xlv, 1339; left bony atresia; M. 37.
- NETO, J. R., *Rev. brasil oto-rino-laryng.*, 1942, x, 431-41; *Index Medicus*; "Trans-palatine Route in therapy of bilateral congenital imperforation of choanae, with report of cases".
- NORDQUIST, 1901; cited Cohn; bilateral bony atresia; F. 15.
- OBERTÜSCHEN (Crefeld), 1887; cited Haag; right bony atresia, M. 23.
- O'MALLEY, *Proc. R. Soc. Med.*, 1928-29, xxii, 160; in discussion; right atresia and antral empyema.
- ÖNODI, A., *Orv. Hetil.*, 1889, xxxiii, 356; *Index Medicus*; "Curious congenital closure of posterior 'choana'"; also abstr.; *J. Laryng.*, 1891, v, 109; left incomplete osseous-cartilaginous atresia; M. 18.
- OTTO, A. W., "Lehrbuch der path. Anat. des Menschen u. d. Thiere"; English trans. (J. F. South), London, 1831; pt. 2, Sect. xv, Cp. 2a, para, 131, p. 181, lines 8-9, no case report; also "Monstrorum sexcentorum descriptio anatomica", Breslau, 1841; cited Altmann; Case 554; bilateral atresia in human fetus.
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- PASTORE, P. N. and WILLIAMS, H. L., *Proc. Mayo. Clin.*, 1939, xiv, 625-27; bilateral bony atresia; F. newborn; right bony atresia, M. 14, and summary of cases, including those of Anderson, seen at the Mayo Clinic.
- PATERSON, D. R., *Proc. R. Soc. Med.*, 1909-10, iii, Laryng. Sect., 114-15; right atresia; F. 41.
- PATTERSON, N., *Proc. R. Soc. Med.*, 1923-24, xvii, Laryng. Sect., 82-84; left atresia; M. 19.
- PAZ, J., *An. Circ. méd. argent.*, 1896, xix, 92; *Index-Cat. Surg. Gen.*; "Imperforación nasal congénita".

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- PETERSON, O. H., *Ann. Otol., etc.*, St. Louis, 1932, xli, 238-39; bilateral ?membranous atresia, F. newborn.
- PFINGST, A. O., *Laryngoscope*, St. Louis, 1914, xxiv, 179-82; bilateral bony atresia, F. 24.
- PHELPS, K. A., *Trans. Amer. Acad. Ophth.*, 1925, xxx, 353-63; also *Ann. Otol., etc.*, St. Louis, 1926, xxxv, 143-51, left bony and right osseo-membranous atresia, F. 4 months, and right atresia, F. 17.
- PIFFL (Bohemia), *Munch. med. Wschr.*, 1910, i, No. 9, '501; right bony atresia and hyperhydrosis, F. 18.
- PLUDER, F., Leipzig, 1896, also *Festschr. arz. Vereins*, Hamb., 1896, S.219-38; *Index Medicus*, cited Haag and Baurowicz, left bony atresia, F. 16.
- POLSON, C. J., *J. Laryng.*, 1942, (a), lvii, 160-77, "Rhinitis Caseosa"; also *ibid.* (b) pp. 416-17; "A post-mortem technique for the inspection and removal of the nasal structures", also *ibid.* 1943, (a) lviii, 79-116, "On Rhinoliths", and *ibid.* (b), 224-37 (231), "Contribution to a discussion on nasal allergy".
- POMEROY, O. D., 1881, cited Hubbell, Casselberry and Haag after Schwendt, right bony atresia, M. 44.
- PONTOPPIDAN, 1916; cited Colver; on the operative treatment of atresia of the choanae.
- PORTER, W. G., *Edinb. med. J.*, 1906, N.S. xix, 129-33, right complete and left incomplete bony atresia, F. 21, also *J. Laryng.*, 1907, xxii, 17-21; "On a fold sometimes to be found in front of the posterior nasal opening"
- PORTO, G., *Brasil-méd.*, 1929, xliii, 1393-95, *Index Medicus*, stenosis and atresia of nasal fossae.
- POTTER, F. H., *Buffalo med. J.*, 1888-89, xxviii, 74-76, *Index-Cat. Surg. Gen.*, 2nd series, xii, 731, as anterior, but *ibid.* p 775, as posterior atresia, *Index Medicus*: anterior atresia.
- PRECHTEL, A., 1938, cited Kelly, D. B., transpalatal operation for atresia
- PRENTISS, see Dean, 1925, bilateral bony atresia, M. about 45, dissecting room specimen.
- PROTA, 1904, cited Balla, four cases of membranous atresia in females of 43-60, ?acquired
- QUADRI, A., *Gac. méd esp.*, 1908, xxvi, 337-40, *Index-Cat. Surg. Gen.*, bilateral congenital atresia, F. 13
- RABINOWITCH, 1913, cited Mouret and Cazejust, case of left atresia
- RAOUlt, *Rev. méd. Est.*, 1903, xxxv, 214, *Index-Cat. Surg. Gen.*, bilateral atresia, M. 22 months
- REVERCHON and DIDIER (Lille), *Ann. Otolaryng.*, Paris, 1933, No. 12, 1440-42, discussion 1442-44, right bony atresia, M. 25
- RICHARDSON, C. W., *Ann. Otol., etc.*, St. Louis, 1913, xxii, 488-91, also *Trans. Amer. laryng. Ass.*, 1913, xxxv, 226-29, discussion 229-31, bilateral bony atresia, infant, newborn, also *Lancet* 1914, ii, 439-44, general account of choanal atresia, no new case report
- RICHTER, E., *Msch. Ohrenheilk.*, 1901, xxxx, 170-72, right membrano-?cartilaginous atresia, F. 6 weeks
- RIDOUT, C. A. S., *Proc. R. Soc. Med.*, 1928-29, xxii, 159, discussion 159-60, bilateral atresia, M. 16
- ROBERTS, G. J., *U.S. Nav. M. Bull.*, 1944, xliii, 1216-19, left bony atresia, M. 18
- ROBERTSON, W., *Brit. med. J.*, 1890, i, 178 "A curious case of occlusion of the choanae", F. 20.

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- ROLLAND, A. J. B., *Gaz. méd. Montréal*, 1889, iii, 155-57; *Index-Cat. Surg. Gen.*; cited Haag; left bony atresia; F. 28.
- RONALDSON, T. R., *Edinb. med. J.*, 1880-81, xxvi, 1035-36; bilateral ?membranous atresia; F. newborn; partial necropsy; first British case.
- ROSE, *Proc. R. Soc. Med.*, 1928-29, xxii, 159; in discussion, brief mention of experience of several cases of atresia.
- ROOT, E. H., *Wom. med. J.*, 1897, vi, 374-76; *Index-Cat. Surg. Gen.*; case of atresia; infant, newborn.
- ROTH, J. H., *Ann. Otol., etc.*, St. Louis, 1926-27, xxxv, 948; left bony atresia, F. 35; also *ibid.*, 961-62; discussion 962-64; right bony atresia; F. 12 (See Roth and Geiger for identical report).
- ROTH, J. H. and GEIGER, C. W., *Ann. Otol., etc.*, St. Louis, 1926-27, xxxv, 849-55; right bony atresia, F. 12 (See Roth, J. H., for identical case report).
- ROTH, W., *Wien. klin. Wschr.*, 1902, xxv, 221; in discussion, mention of case of bilateral bony atresia.
- RUGGERI, L., *Boll. Mal. Orecch.*, 1909, xxvii, 265-68; right bony atresia, F. 15.
- RUGH, J. T., *Philad. Polyclin.*, 1897, vi, 144; also abstr., *J. Laryng.*, 1897, xii, 465; right membranous atresia; F. 18.
- RUTLAND, W. H., 1918; cited Hart and Colver; bilateral bony atresia, infant, newborn.
- SANTESSON, Forhandlinger vid Svenska läkare Sällskapets Sammenkomsta, 1866; Stockholm, 1867, p. 303; *Index-Cat. Surg. Gen.*; cited Haag and Altmann via Schwendt; bilateral bony atresia; M. 23.
- SANTI, G., *Valsalva*, 1928, iv, 481-91; *Index-Cat. Surg. Gen.*; "Contributo ai diaframmi congeniti delle coane (nota clinica)".
- SATTLER, E. E., *Clin. Chron.*, May 1896; abstr., *J. Laryng.*, 1896, xi, 162-63; right bony atresia; F. 24, and left bony atresia; F. about 30.
- SCHADEWALDT, *Berl. klin. Wschr.*, 1897, xxxiv, 79; in discussion, case of atresia; F. 30.
- SCHAEFFER, J. P., *Laryngoscope*, St. Louis, 1933, xlili, 480-81; General observations on causation of atresia; also *Trans. Amer. Laryng. Ass.*, 1934, lvi, 126-31; general statement; no case reports.
- SCHÄFFER, 1885; cited Haag from Schwendt, and Knight; right bony atresia; M. 15.
- SCHEIER, M., *Berl. klin. Wschr.*, 1904, xli, No. 18, 483; right bony atresia; F. 21.
- SCHEPPEGRELL, W., *Ann. Ophth. Otol.*, 1894, iii, 177-81; left atresia; F. 27; and right bony atresia; F. 16.
- SCHLEMMER, F., *Mschr. Ohrenheilk.*, 1912, xlvi, 1145-64; left incomplete membranous atresia; F. 44; Chiari's Type V (1909).
- SCHMIEGELOW, D. E., *Verhandl. dänischen oto-laryng. Vereins*, 20 October, 1900; rep., *Mschr. Ohrenheilk.*, 1900, xxxiv, 442-44 (S.444); bilateral congenital atresia; F. 17, and bilateral bony atresia; M. 36; also abstr. *Ann. Otol., etc.*, St. Louis, 1904, xiii, 178; (J. F. Fischer), bilateral, probably membranous atresia, F. 30; also *Ugeskr. Læg.*, 1915, lxvii, 1295-98; *Index-Cat. Surg. Gen.*, "A contribution to the surgical treatment of congenital atresia of the nares".
- SCHOETZ, (Berlin); 1887; cited Schoetz 1897; bilateral bony atresia, F. 16; also *Berl. klin. Wschr.*, 1897, xxxiv, 79; left bony atresia; F. 13.
- SCHÖNSTADT, *Berl. klin. Wschr.*, 1907, xliv, 965, left bony atresia; M. 15 weeks.

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- SCHUTTER, W., Dutch Soc. Laryng. Rhin. Otol., July 1894, rep, *J. Laryng.*, 1895, ix, 465-6, right bony atresia; M. 59; cast of nose shown
- SCHWARTZ, A. A and ISAACS, H. J., *Arch. Otolaryng., Chicago*, 1942, xxv, 603-12, right bony atresia, F. 18, and right mixed atresia, autopsy and detailed histology with illustrations, M. 55.
- SCHWECKENDIEK, H., *Z. Hals-Nas.-u. Ohrenheilk.*, 1937, xlii, 367-73, five cases, details of 2 incomplete, 4 unilateral, 1 left, 3 right, transpalatine operation
- SCHWENDT, A., "Die Angeborenen Verschlüsse, etc.", *Rheims*, 1890, review, *J. Laryng.*, 1890, iv, 359-60, cited Haag, and others, bilateral bony atresia, F. 15, table of 25 cases, good illustrations, also *Mschir. Ohrenheilk.*, 1897, xxii, 105-12; *Index-Cat. Surg. Gen.*, cited Daubret, bilateral bony atresia, F. 15.
- SCOPPETTA, G., *Boll. Mall. Orecch.*, 1908, xxi, 168-77, right membranous atresia, M. 19, and brief details of two other cases
- SERCER, A., *Rev. Laryng.*, Paris, 1923, xliv, 903-11; bilateral bony atresia, F. 13.
- SESSOUS, *Beil. klin. Wschr.*, 1904, xli, 798, bilateral bony atresia, F. 5
- SIEBENMANN, (Basel), *Munch. med. Wschr.*, 1897, xli, 983-85; "Ueber adenorden Habitus und Leptoprosopie sowie über das kurze Septum der Chamaeprosopen", also *Wien. med. Wschr.*, 1899, No. 2, xlvi, 58-62, "Nasenhöhle und Gaumenwölbung bei den verschiedenen Gesichts-Schadelformen", no case reports
- SILVER, A., *Med. Times Gaz., Lond.*, 1870, ii, 619, *Index-Cat. Surg. Gen.*, "Occlusion of the posterior nares".
- SIMON, 1897, cited Haag, Porter and Baurowicz, right bony atresia, F. 10, and *ibid.*, M. 32.
- SOLLY, E., *Trans. clin. Soc., Lond.*, 1891-92, xxv, 282, bilateral atresia, F. 16
- SOMMER, (Prague), *Wien. med. Presse*, 1883, xxiv, 476, *Index Medicus*; cited Schroetter, left bony atresia, M. 19
- STEINZEUG, A., *Arch. Ohr-Nas.-u. Kehlk.-Heilk.*, 1933, cxvii, 364-66, transpalatal operation, no case report.
- STEWART, J. P., *Arch. Otolaryng., Chicago*, 1931, viii, 570-83, bilateral bony atresia, F. 18 and *ibid.*, F. 15, sisters, skiagrams, key paper, mention of 6 other cases, one published by Fraser, at Edinburgh
- STINSON, W. D., *Arch. Otolaryng., Chicago*, 1932, xv, 101-03, bilateral bony atresia, F. 7 months, and right bony atresia, F. 14.
- STOUT, G. C., *J. Amer. med. Ass.*, 1897, xxviii, 977, case of anterior nasal atresia, M. 3 months.
- STUPKA, W., *Z. Hals-Nas.-u. Ohrenheilk.*, 1931, xxix, 322-350 "Zur Pathogenese der Choanal-atresie, bibliography, no case reports.
- STUTZ, L., *Z. Ohrenheilk.*, 1912, lxv, 202-05, left atresia, F. 12.
- SUCHANEK, H., Dem. Gesellsch. Arz Canton Zurich, 17 November, 1892, rep, *J. Laryng.*, 1892, vi, 277, bilateral bony atresia, M. 11.
- SWAIN, *Laryngoscope*, St Louis, 1907, xvii, 316, in discussion, mention of two cases.
- SYMONDS, C., *J. Laryng.*, 1895, ix, 506, in discussion, case of atresia resembling that of Ball.
- TARASIDO, A. (or TARASODI), 1920, cited *Index Bibliog., Rev. Laryng.*, 1923, xliv, 17, 41, "Atresie Choanale".
- TAWS, H. B., *J. Laryng.*, 1912, xviii, 359-60, right bony atresia, M. 30
- TEXIER, V., *Rev. Laryng.*, Paris, 1906, ii, 209-11, *Index Medicus*, *ibid.* 1906, i, 742-44, left bony atresia, F. 29, *ibid.*, F. 19 and bilateral atresia, infant, newborn.

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- THACKER-NEVILLE, W. S., *J. Laryng.*, 1927, xlvi, 48-49; bilateral bony atresia; F. 10 days.
- THEESSEN, S., *Z. Laryng. Rhinol.*, 1926-27, xv, 193-208; left bony atresia; F. 20; illustrations; bibliography.
- THOMASSON, W. J., *Laryngoscope*, St. Louis, 1915, xxv, 221-23; right bony atresia; M. 29.
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## THE REPAIR OF THE DEPRESSED NASAL BRIDGE

By STEPHEN SUGGIT (London)

DEPRESSION of the nasal bridge produces an ugly deformity, which frequently causes worry and anxiety to the patient. The surgical repair of this deformity is not difficult and well repays the trouble taken. Mowlem has pointed out the advantages of a bone graft over a cartilage graft. Cartilage grafts tend to become distorted. The iliac crest is an accessible donor site, and after removal of the compact outer layer provides a graft consisting entirely of vascular cancellous bone. In this series of five cases, four were repaired by a cancellous graft from the iliac crest, following the general lines of the technique described by Mowlem in his paper.

CASE I. Able seaman aged 21, fracture of nose as a child admitted 31.5.44, with subacute left frontal sinusitis. 5.6.44 left external frontal sinus operation. The convalescence from this operation was uneventful and the man himself was very anxious to have the bridge of his nose raised. There was gross flattening of the upper part of his nose.

19.6.44: a graft was cut from the crest of the right ilium with an osteotome. After removing the superficial compact layer of bone with a Bard-Parker knife, a cancellous graft 5 cm. long was available. A transverse incision  $\frac{3}{8}$  inch long was made in the tip of the nose just above the nares. By combined blunt and sharp dissection, a tunnel was made between the skin superficially and the nasal skeleton beneath, and reaching the root of the nose above. The bone graft was then pushed up the tunnel from below and the skin at the tip of the nose closed with eyeless sutures.

The graft is shown in position in figure 1, and the clinical result was entirely satisfactory.

CASE II. Petty Officer aged 28. He had broken his nose at the age of 17, and in 1938 a submucous resection of the nasal septum had been done. He had continued boxing, and the middle part of his nose was grossly depressed. 3.8.45, a bone graft from the crest of the right ilium was inserted into a prepared tunnel beneath the skin of the nose, using the same technique as in the previous case. In addition a small bone graft was inserted downwards to reinforce the columella. Both grafts can be seen in figure 2. The profile of the nose before and after the operation is shown in figure 3. Before operation he had complained of "whistling" through his nose. How this occurred was not clear, but it disappeared immediately following operation.

# Stephen Suggit

CASE III. Engineer aged 26 ; he had broken his nose eight years previously, and had complained of frontal headaches for one year. The problem here was different from the two previous cases. The bridge of the nose was both flattened and deviated to the left.

26.10.45 : a vertical incision was made on each side of the nose. The skin and soft tissues were raised off the fractured nasal bones. The nasal septum lay between the nasal bones which it had separated. A submucous resection of the nasal septum was then done. One small bone fragment was removed, and the nasal bones levered into place. The cartilage from the septum was cut into strips and laid over the nasal bones, before closure of the skin incisions with eyeless sutures. Figure 4 shows the nasal profile before and after operation. The lateral deformity of the nose was completely corrected and an adequate airway restored. A bone graft would have given a rather better result, but as no preparation had been made before operation for taking a bone graft, I decided to use the cartilage which was available from the septum.

CASE IV. An engine room artificer aged 26, he had fractured his nose three years previously. He had a prominence of the upper part of the bridge, which was splayed, and below, a marked depression.

29.10.45 : a horseshoe incision was made over the bridge of nose and the antero-lateral parts of both nasal bones removed. A cancellous bone graft was cut from the crest of the right ilium, and inserted from the incision downwards beneath the subcutaneous tissues towards the tip. Figure 5 shows the profile before and after operation.

CASE V. A Norwegian engineer serving in the Royal Navy, aged 28. He had fractured his nose four years previously, and an attempt at reduction had been made soon afterwards. There was no lateral deformity, but gross depression of the bridge of the nose was present.

26.11.45 : a bone graft from the right iliac crest was inserted from below, as in Cases I and II. Surgeon Lieutenant D. Johnston, R.N.V.R., assisted me by cutting the bone graft from the iliac crest while I was preparing the tunnel in the nose, and we were able to cut the operation time down to  $\frac{3}{4}$  hour.

Figure 6 shows the bone graft in position, and figure 7 the profile before and after operation.

\* It is essential to ensure complete haemostasis in the wound of the iliac crest, by using bone wax on the bleeding bone surface and checking bleeding points in the soft tissues. A haematoma in this situation must be avoided. It is wise to keep the skin sutures in the iliac wound in for ten days, and not to allow the patient to get up until they are removed. The first patient in the series was allowed to get up while the sutures were still in situ. This resulted in slight gaping of the lower part of the wound incision and considerably more stiffness than in the remaining three bone grafts. In no case was the nose splinted, and there was no tendency of the graft to shift. The skin incisions are best left without dressings other than dusting with sulphonamide powder until a dry



FIG. 1

X-ray of Cancellous bone graft in case 1.



FIG. 2.

X-ray of Cancellous bone graft in case 2



FIG. 3

Profile of case 2 before and after operation.



FIG 4

Profile of case 3 before and after operation, and insertion of cartilage grafts from the nasal septum.

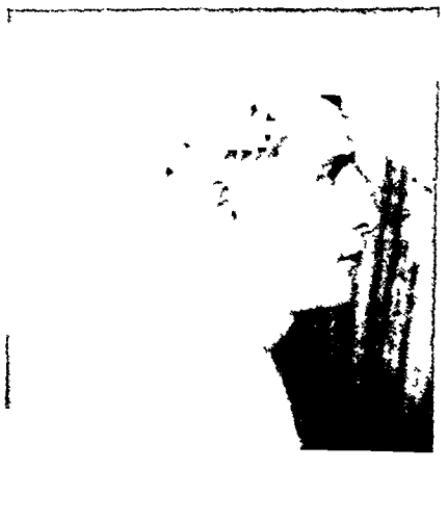


FIG 5

Profile of case 4 before and after operation and insertion of cancellous bone graft

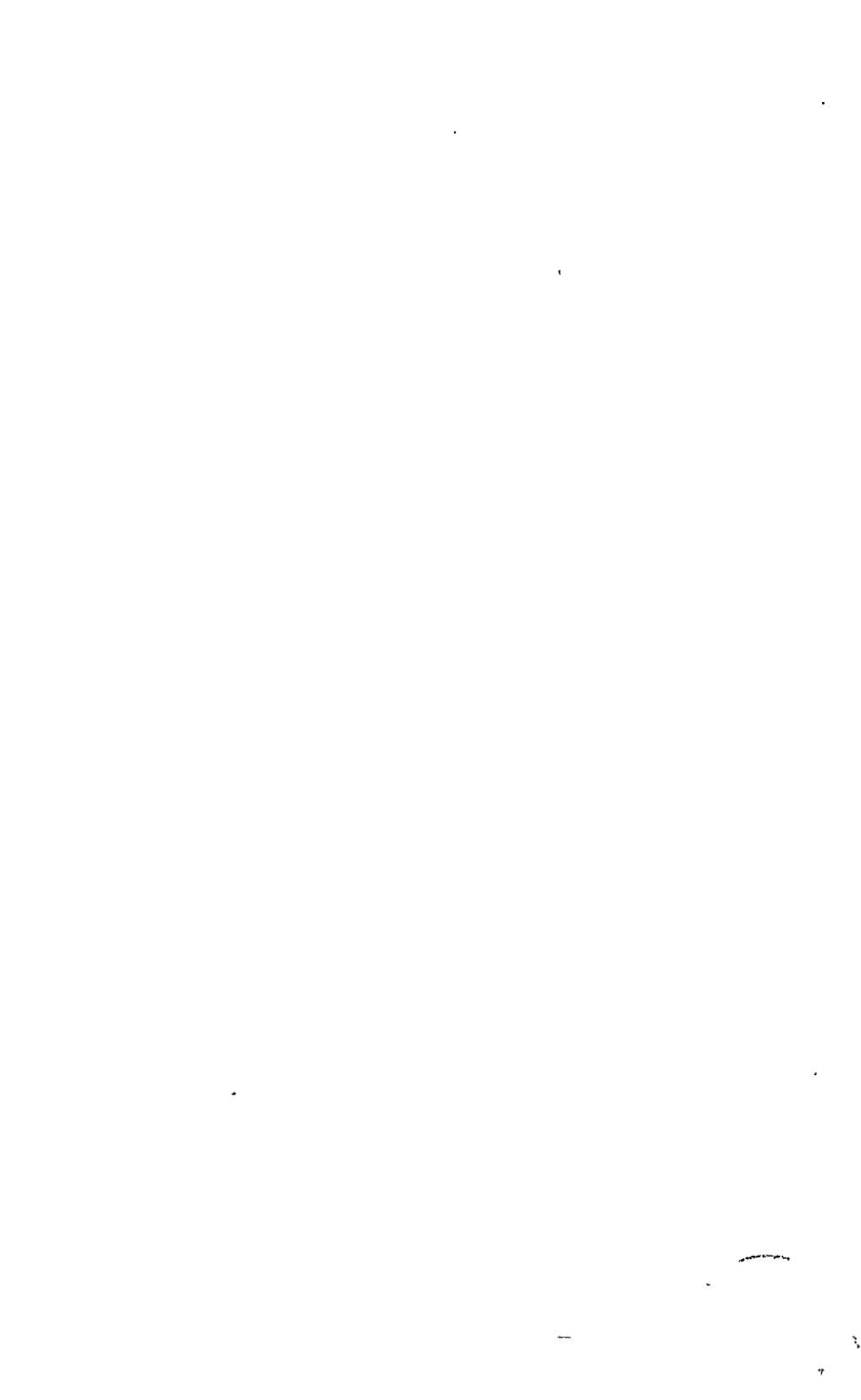
FIG 6

X-ray of cancellous bone graft in case 5.



FIG 7

Profile of case 5 before and after operation.



# The Repair of the Depressed Nasal Bridge

crust forms. The X-ray pictures shown were taken about two weeks after operation.

In conclusion I wish to thank the radiographic staff at R.N. Auxiliary Hospital, Barrow Gurney for their kind help in the preparation of the photographs, and the Medical Director-General of the Royal Navy for permission to publish these cases.

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# WOUNDS OF THE MASTOID PROCESS

## (A REPORT ON ELEVEN CASES)

By J. MAGILL (late R.A.M.C.)

BATTLE injuries of the mastoid process were not frequently seen in the E.N.T. Departments of General Hospitals. Many of them had associated intra-cranial or maxillo-facial injuries which necessitated their treatment in special centres.

During the period April 1944 to April 1945 while serving in Italy, with a General Hospital which had both Maxillo-Facial and Neuro-Surgical Units attached, I had the opportunity to treat eleven of these cases which were not associated with intra-cranial injury.

It is the purpose of this short paper to describe the salient points of these cases and their treatment.

### Causal Agent

In this series all the cases, with one exception due to a machine-gun bullet, were the result of high explosive shells and grenades.

### Type of Wound

The extent of the damage to the mastoid process and soft tissues varied considerably, from tangential of the cortex, perforation of the process with the foreign body lying deep in the neck, to gross comminution of the process and loss of bone substance.

### Condition of the Mastoid at Operation

Changes in the mastoid process due to the injury and subsequent sepsis varied considerably. Severe comminution of the whole process was observed in one case.

The mastoids showed the result of infection, purulent and serous effusions being the rule except in one case in which the cells were filled with breaking down blood clot.

### Associated Conditions

All the cases were complicated by one or more other conditions. The commonest of these was sepsis which varied in degree, but was in no case severe, and in all was localized to the wound area. This high incidence of sepsis was probably due to the fact that the cases were received relatively late, some of them months after wounding, and untreated.

## Wounds of the Mastoid Process

Metal stenosis was common, particularly in those cases in which some healing had taken place. The stenosis was mainly due to injury of the meatus by the missile. In one case it was found at operation that the root of the zygoma and the antero-superior meatal wall had been fractured and displaced downwards and backwards lacerating and obstructing the meatus.

Otitis media was present in all but two cases and was the result of infection of the middle ear through a blast perforation which had occurred at the time of the injury.

Facial paresis occurred three times in the series. In only one case was it considered that the injury to the nerve might be in some part of its course through the mastoid process. In this case the nerve was exposed from the stylo-mastoid foramen to the level of the lateral semi-circular canal but no lesion was found, recovery of function followed.

Deafness was present in all the cases, it was of mixed type and varied in degree. It was probably the result of the blast perforation and co-existing otitis media, and the labyrinthine concussion consequent on the close passage of a high velocity missile.

Nystagmus and transient vertigo, particularly on change of position, was a feature of some of the cases. This was increased by operation but settled spontaneously in the course of a few weeks. In no case was there evidence of major labyrinthine damage.

### Investigation and Treatment

Experience showed that it was possible to divide the cases into four groups depending on the extent of trauma to the mastoid process, the presence of otitis media, and the presence of metal stenosis or such injury to the meatus as would make stenosis inevitable.

Preliminary investigation included aural examination with assessment of hearing. Routine X-rays were taken in the lateral oblique and Townes' position in every case.

#### GROUP I.

This group consisted of those cases which presented tangential wounds of the cortex, particularly if the process was a diploetic or sclerotic one, or if the cells had not been widely opened and infection was slight.

The cases in this group were treated by simple excision and suture of the wound.

#### GROUP 2.

In this group were included those cases with comminution and retained foreign bodies.

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The usual mastoidectomy incision was employed and, if practicable it was made to encircle the wound, the edges of which were excised. After the reflection of the soft tissues and periostium, loose fragments of bone and accessible foreign bodies were removed. Sufficient of the bone of the rest of the process was excised to get beyond the limits of infection. The cavity if small, was then insufflated with penicillin-sulphathiazole powder and the wound closed in one layer.

When the cavity was large a small rubber tube was used through which penicillin was instilled into the cavity. The upper end of the tube was placed in the antrum and it was brought out at the lower end of the wound which was tightly closed around it.

The free end of the tube was brought out through the dressing and in order to exclude infection it was closed by tying tightly with silk-worm gut.

At the end of the operation the cavity was filled with calcium penicillin solution (500 units per c.c.) by means of a syringe the needle of which was inserted through the wall of the tube into its lumen.

During the first five post-operative days the tube was aspirated twice daily and further instillations of approximately 5 c.c.s made.

The dressing was not disturbed until the sixth day, the stitches and tube were then removed and daily dry dressing instituted until the wound was healed.

## GROUP 3.

The cases in Group 3, were those cases in which there was evidence of infection of the greater part of the mastoid process, those in which there was haemorrhage into the mastoid cells, and those in which otitis media was present.

The operation performed was the classical Schwartz and included the removal of accessible foreign bodies and loose bone chips.

The wound was closed in one layer and penicillin instillation used as in Group 2.

## GROUP 4.

This group was made up of the cases which had established meatal stenosis or injury which made stenosis likely to occur during healing.

It was considered that some form of plastic procedure on the meatus was essential, both to avoid deafness from this cause alone, and to facilitate the treatment of the middle ear. The Heath operation was performed in these cases.

The presence of even a severe degree of nerve deafness was not considered to be a contra-indication to this procedure. Nerve deafness due to blast shows a considerable tendency to spontaneous recovery of at least useful hearing over a period of months.

## Wounds of the Mastoid Process

The incision was made well forward, if possible encircling the wound and excising its edges. The mastoid antrum was opened in every case. The posterior meatal wall was lowered to leave only a narrow bridge over the aditus. A Korner flap was then cut and stitched back. Where the meatus was much lacerated the formation of this flap was a matter of considerable difficulty, in some cases the remains of the posterior meatal wall had to be away and the meatus enlarged by the removal of a small rim of cartilage from its margin.

The cavity was then packed with ribbon gauze soaked in B.I.P.P. cream. Dressing was performed on the sixth day, the pack was removed and a fresh one substituted, stiches were removed at the same time. This dressing was invariably performed under pentothal anaesthesia.

Packing was discontinued on the fourteenth day and the cavity treated daily with insufflation of penicillin-sulphathiazole powder until epithelialization was complete.

The operation was extended, in one case, to expose the facial nerve from the stylo-mastoid foramen to the level of the lateral semi-circular canal.

Primary skin grafting was attempted in one case. The graft was taken from the anterior aspect of the thigh and packed into position with ribbon gauze soaked in B.I.P.P. cream. Sodium penicillin (300,000 units) were given intra-muscularly during the first three post-operative days. The graft took completely.

### Cases

I. Part. S. Wounded several weeks previously. Entry at the external canthus of the left eye. Exit at the tip of the left mastoid which was fractured, sclerotic mastoid, complete facial paresis.

Treatment dry dressing only.

Result, healed in one month, no recovery of paresis, hearing poor.

II. Pte. H. Wounded three days previously. Perforating wound of the tip of the left mastoid with acellular, metallic foreign body deep in muscles of neck.

Operation, removal of bone chips, excision of wound and suture, foreign body not removed.

Result healed in twenty one days, hearing good.

III. Fus. G. Wounded September 5th. Operation at advanced section of M.F.U. the same day, metallic foreign body removed and extensive laceration of meatus noted. Wound excised and sutured.

September 21st. Profuse purulent discharge from meatus which was stenosed and filled with granulations.

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September 28th. Operation, abscess cavity found in mastoid process discharging through the posterior meatal wall. Heath mastoidectomy performed, posterior meatal wall fractured by the missile, antrum full of pus.

Result discharged on November 22nd to duty, healed moderate degree of mixed deafness persisting.

IV. Part. S. Wounded three weeks previously, not treated, entry wound at external canthus of right eye, exit one inch behind attachment of pinna at level of the external meatus, missile had crossed the meatus which was completely stenosed, deafness severe, bone conduction present. Complete facial paresis.

July 29th. Operation, Heath mastoidectomy, septic cavity in mastoid due to the passage of the missile, many bone fragments removed.

October 6th: Result, cavity healed, hearing present but not useful. No recovery of paresis.

V. Part. M. Wounded March 31st. Not treated. Entry behind and below external canthus of right eye. Exit half an inch behind attachment of right pinna and half an inch above the centre of the external meatus. Meatus stenosed, discharge profuse, deafness severe. Discharging sinus present at exit wound.

June 28th. Operation, cavity found in mastoid process communicating with the antrum and the meatus. Posterior meatal wall and root of zygoma fractured and displaced downwards and backwards lacerating and occluding the meatus. Schwartz mastoidectomy completed and an attempt made to reconstitute the meatus around a rubber tube. Penicillin tube inserted in the lower end of wound.

August 6th. Result, wound healed, complete meatal stenosis, small amount of discharge from the meatus, no useful hearing present, bone conduction only.

VI. Rfm. D.R. Wounded September 21st. Not treated, severe laceration of scalp and pinna, infection slight. X-ray, mastoid comminuted, multiple metallic foreign bodies present.

September 28th. Operation, wound excision, removal of accessible foreign bodies, pinna repaired, suture of wound.

December 8th. Result, healed, hears conversation at three feet.

VII. P.O.W. W. Wounded December 20th, not treated, entry over mastoid process two centimetres above tip, exit in right zygomatic region, infection of wound and middle ear.

January 3rd. Operation, Schwartz mastoidectomy, irregular guttered deficiency of mastoid involving the posterior meatal wall and zygomatic region. Infection of mastoid cells and antrum. Penicillin tube.

January 23rd. Result, healed, meatus dry, hears whispered voice at three feet.

VIII. Sgt. B. Wounded one week previously, wound of mastoid process missile having crossed meatus. Otitis media present.

Treated conservatively for two months.

## Wounds of the Mastoid Process

September 10th. Wound healed, meatus stenosed, middle ear still discharging. Evacuated for further treatment.

IX. P.O.W. U. Wound of mastoid process involving meatus, complete facial paresis. Meatal discharge profuse, hearing poor.

January 17th. Operation, excision of wound and removal bone fragments, exposure of facial nerve from stylo-mastoid foramen to level of lateral semi-circular canal, no injury found. Primary skin graft to cavity. Sodium penicillin (300,000 units) given during first three post-operative days.

April 22nd. Result, wound healed, small amount of discharge from middle ear. Facial nerve which showed signs of recovery at the end of a fortnight, completely recovered. Hearing not useful.

X. P.O.W. Z. Wound of mastoid process two weeks before admission. Untreated, meatus severely stenosed, otitis media present.

December 2nd. Operation, Heath mastoidectomy, mastoid tip comminuted cells filled with pus. All loose fragments removed. Wound sutured in one layer.

April 26th. Result, wound and cavity healed, small amount of discharge from middle ear. Hearing not useful.

XI. Rfm. M. D. Wounds of scalp and mastoid process. Entry wound in right malar region, exit wound behind right ear. Missile had crossed the meatus, middle-ear infection present.

January 9th. Operation, Heath mastoidectomy, loose fragments of posterior meatal wall removed. Purulent infection of all mastoid cells. No meatal plastic possible as soft parts too lacerated, remains of posterior meatal wall removed.

February 25th. Result, healed cavity, ear dry. Hearing not useful.

### COMMENTARY

Eleven cases of wounds of the mastoid process and the methods used in their treatment are described. The plan of treatment was found to be applicable to all of the cases.

The ten cases in which treatment was completed in the hospital, were discharged with soundly healed wounds and eight of the cases had dry ears.

The result in Case V was not satisfactory, the attempt to maintain patency of the meatus by means of a rubber tube was not successful, the meatus stenosed rapidly as soon as it was removed. The meatus became so narrow that treatment of the residual otitis media was practically impossible. Hearing by air conduction was absent although some bone conduction remained. The result might have been considerably improved if an operation of the Heath type had been undertaken.

There was no improvement in Case VIII despite two months conservative treatment of the meatus. Although the X-ray was negative, it is

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possible that there was fragmentation of the posterior meatal wall and sequestration that prevented healing. An operation of the Heath type was also indicated in this case.

Facial paresis was present in three cases. In one of these it was considered that the lesion might be in some part of the nerve's course through the mastoid process.

The nerve was exposed from the stylo-mastoid foramen to the level of the lateral semi-circular canal. Although no injury was found, recovery commenced in a fortnight and was complete on discharge from hospital.

This was in marked contrast to the other two cases, one of these showed some improvement in two and a half months, the other showed no improvement at all.

The quick improvement of this case suggested that the paresis might be due to oedema of the nerve within the facial canal, and that recovery was hastened by its decompression. It was proposed to expose the nerve in any further cases of this type but the end of hostilities precluded this.

Primary skin grafting followed by intra-muscular administration of penicillin was used in one case. The result was entirely satisfactory, the graft took completely and a perfectly healed cavity resulted. I have used post-operative penicillin in two cases of radical mastoidectomy with primary grafting, the two grafts took completely in each case.

The results as regards hearing were very poor indeed. In only three cases was any useful degree of hearing retained. The period of observation was short and it is possible that further improvement might take place. Language was also a problem in assessing hearing, only three of the patients spoke any English and this made accuracy impossible.

## ACKNOWLEDGEMENT

My thanks are due to Colonel Ward, D.S.O., M.C., who commanded the hospital for permission to publish this paper.

## ABSTRACTS NOSE

*Colloidal Salt Nasal Tamponades: their use and abuse.* GEORGE D. WOLF, M.D. (New York, U.S.A.). *Jour. A.M.A.*, February 2nd, 1946, cxxx, 5, 273.

Solutions of mild protein silver used either as nasal drops or on tampons have enjoyed considerable popularity both with the public and with the profession. In some well selected instances, this treatment may produce very satisfactory results and these results may be due to free silver ions. Prolonged nasal tamponage has no physiologic or pharmacologic basis and the method should be discontinued. The continued use of tampons may produce ciliary damage, nasal allergy or possibly argyria. ANGUS A. CAMPBELL.

### ŒSOPHAGUS

*The Injection Treatment of Œsophageal Varices.* CECIL O. PATTERSON, M.D. and MILFORD O. ROUSE, M.D. (Dallas, Texas). *Jour. A.M.A.*, February 16th, 1946, cxxx, 7, 384.

(Œsophageal varices are not uncommon in splenomegalia or cirrhosis of the liver. These bulbous veins project into the œsophageal lumen and are daily subjected to trauma from swallowed food. Ulceration and rupture may result in massive blood loss.

Persistent and sternal distress occurring in a patient with suspected œsophageal varices indicates the need of X-ray study and probably œsophagoscopy and injections of any veins large enough to produce symptoms. The solution used for injection is 1 c.c. of 5 per cent. sodium morrhuate in each varix.

The writers have used this injection treatment in twelve patients, the youngest three years of age, the oldest sixty six.

From their experience, they feel the injections are well worth while, but further careful observations will have to be made to justify the procedure fully.

ANGUS A. CAMPBELL.

### MISCELLANEOUS

*Rubella in Pregnancy causing Malformations in Newborn.* MAX J. FOX, M.D. and MORTIMER M. BORTIN, M.D. (Milwaukee). *Jour. A.M.A.*, March 2nd, 1946, cxxx, 9, 568.

Investigation is being directed at the present time to congenital malformation of the newborn of mothers who have had rubella during pregnancy. The congenital anomalies noted have been cataracts, deaf-mutism, heart disease, etc. All of the investigators fail to cite the total number of women having rubella in pregnancy and who had no congenital defects in the offspring. The writer presents data covering a three year period, noting the total number of recorded cases and investigating whenever possible all married women having had the disease and interviewing all pregnant cases as to the status of the child.

In a survey, 1942-1944, 22,226 cases of rubella were reported in the city of Milwaukee, of which 152 married women were investigated. Of these, eleven were pregnant at the time they had rubella. Of these eleven the disease occurred during the first two months in five, during the fourth month in four, the seventh month in one and the ninth month in one. In the eleven cases, one stillbirth occurred but all the others were normal. One of these women who bore a healthy child when she had rubella, gave birth to a child with congenital cataracts during a previous normal pregnancy.

## Abstracts

From these studies, the writer does not think pregnancy should be terminated because of rubella but that further studies should be given to subject of virus diseases in pregnant women. ANGUS A. CAMPBELL

*Inhalation Method for Penicillin Therapy: A Preliminary Report.* E. HAGENS, MARY CARP and C. J. FARMER.

This report, by a team of workers in Chicago, relates to a series of twenty-two patients who were treated with penicillin by the inhalation method. Examination of urine and blood showed that a sufficient amount of penicillin was absorbed from the lungs to justify the use of this route as an alternative to other channels. The inhalation method had the added advantage of combining the local with the general effect, and for that reason it may become the method of choice in pulmonary disease.

Ten of the patients were cases of bronchiectasis, five suffered from pneumonia, four from asthma, two from pharyngitis and sinusitis, and one from abscess of the lung. Bacteriological examination was made in all cases and in most cases Gram-negative bacteria were found, so that another antibiotic substance was necessary, one to which these bacteria are sensitive. The results of this preliminary trial were encouraging, and appear to justify continued investigation and the search for improved technique.

DOUGLAS GUTHRIE.

*An Analysis of Colds in Industry.* JOSEPH H. KLER. *Archives of Otolaryngology*, June, 1945, xli, 6.

The common cold presents a major health problem which is the concern of all physicians, and is of special interest to the oto-laryngologist, as it is the chief cause of sinusitis and of deafness due to middle-ear disease.

The importance of the problem from the industrial standpoint requires no emphasis. Colds are responsible for more than one third of the total number of days lost in American industry, involving a loss of ten million working days each year, and of almost two billion dollars. The author of the present article reports upon a survey of the various factors involved, and sets forth his data in a very interesting series of 26 charts. In his investigation he was assisted by the research staff of the firm of Johnson and Johnson, among whose employees the results were obtained. Colds show a definite seasonal incidence, highest in December and lowest in July. Sudden falls in temperature are followed by a rise in the incidence and also in the severity of colds. It is a curious fact that more colds start on Monday than on any other day of the week.

The incidence and severity are both much greater in women than in men, and the majority of colds in women appear at the time of menstruation.

The incidence and severity of colds is greater among office workers than among factory workers, and greater in draughty premises than in air-conditioned plants. Those who walk about in the course of their work are less liable to colds than those whose work is entirely sedentary.

Although the author vaunts no panacea for the common cold, he states that the duration is shortened by early treatment, staying at home in the early stage, together with the use of such simple remedies as aspirin and hot drink or gargles.

DOUGLAS GUTHRIE.

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